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TECHNICAL EVALUATION OF THE 60 FOOT SMALL WATERPLANE AREA TWIN HULL (SWATH) SHIP HALCYON

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16. Abstract

A technical evaluation of the 60 foot SWATH ship HALCYON built by RMI, Inc., National City, California was conducted by the Coast Guard Research and Development Center. Ship motions were measured aboard the vessel in five headings relative to the 7.4 foot significant seas while cruising at 17.5 knots and in head and beam seas while dead in the water. Ship response amplitude operators (RAO s) were computed for roll, pitch, and heave motions. Ship motions are compared between the HALCYON and an 82' Coast Guard Patrol Boat (WPB) in the same 5 foot sea state using RAOs. Calm water engine horsepower and fuel consumption data were collected, along with towing, bollard pull, noise levels, maneuvering and tactical data. Conclusions are presented on the utility of SWATH ships for rough water area operations in support of Coast Guard patrol boat missions.

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SWATH, HALCYON, SD-60, TECHNICAL EVALUATION, ~~WPB~~ SEAKEEPING, ~~RAO~~ TACTICAL DATA, ~~RMI~~ (JES)

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METRIC CONVERSION FACTORS

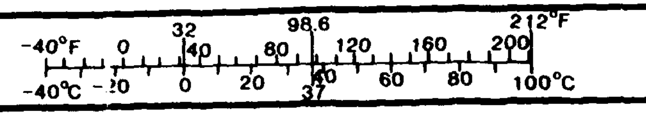
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (WEIGHT)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (EXACT)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25. SD Catalog No. C13.10.286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (WEIGHT)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (EXACT)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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INTRODUCTION

The United States Coast Guard is in the process of evaluating advanced surface craft concepts as well as documenting the performance of its present Patrol Boat Classes (WPB) to support the WPB acquisition process. The Coast Guard Research and Development Center has been directed under the Marine Vehicle Technology (MVT) program's 9207.2 Ship Test and Evaluation element to collect baseline data on the 60 foot small waterplane area twin hull (SWATH) ship HALCYON. Prior to this evaluation, the Coast Guard had collected similar data on the 89 foot SWATH ship SSP KAIMALINO, which is owned by the U.S. Navy.

This data will be incorporated into the vessel data base to support the WPB vessel acquisition in two ways. First, the baseline performance data can be used directly by Coast Guard Headquarters personnel when evaluating proposed replacement craft and candidates for operational evaluations. Secondly, the R&D Center will use the data as input for various operations analysis computer models which evaluate a vessel's ability to perform Coast Guard missions, such as search and rescue, law enforcement and buoy tending.

BACKGROUND

The HALCYON, also known as the SD-60 SWATH demonstrator craft, was built by a privately owned small busines, RMI, Inc., San Diego, California. A Coast Guard Research and Development Center test team set up instrumentation on the vessel in April 1985, approximately two months after the launching. The vessel, however, was not ready for testing at that early date. An idler pulley shaft broke and other problems relating to shaft material specifications were encountered which required replacement of some shafts. This engineering delay forced us to abort the first techeval effort before any usable data could be collected. The follow-up techeval was conducted from 23 October to 3 November

1985 at a period when higher sea states could be expected. There were no engineering casualties during this second evaluation and the HALCYON performed admirably well during the seven days we were underway.

DESIGN OVERVIEW

The HALCYON is constructed of a marine grade aluminum alloy, with all primary hull structural elements continuously welded. Our observations substantiated this; the vessel is very well constructed. RMI considers this a first in aluminum ship construction and has also applied their newly acquired continuous aluminum welding expertise to an 80' surface effect ship (SES) they are building for the U.S. Navy.

The hull, as seen in Figure 1, consists of a rectangular cross-structure, 60 feet long by 30 feet wide and 2-1/2 feet deep, with a two level deckhouse on the forward section. This cross-structure is supported 9-1/4 feet above the centerline of two five-foot diameter cylindrically shaped lower hulls by two tapered strut/sponson assemblies. There are four ride control surfaces inboard on the cylindrical hulls. There are two stabilizer canard surfaces (6.25 sq. ft. area each) forward and two stabilizer fins (16 sq. ft. area each) aft. Design specifications are listed in Table I.

This SD-60 SWATH "HALCYON" differs in several respects from the 89 foot SWATH SSP KAIMALINO which we tested in 1983 (Reference 2). The HALCYON is smaller in displacement; 60 long tons (LT) vs 225 LT of the KAIMALINO. This techeval gave us an excellent opportunity to evaluate how a relatively small SWATH ship could perform in seakeeping. The KAIMALINO has two struts per side while the HALCYON has one continuous strut per side. The KAIMALINO's hull is steel and the superstructure aluminum, while the HALCYON is all aluminum construction. The KAIMALINO has one continuous athwartship aft stabilizer fin which connects the two pods. It is powered by two gas turbines in the cross box

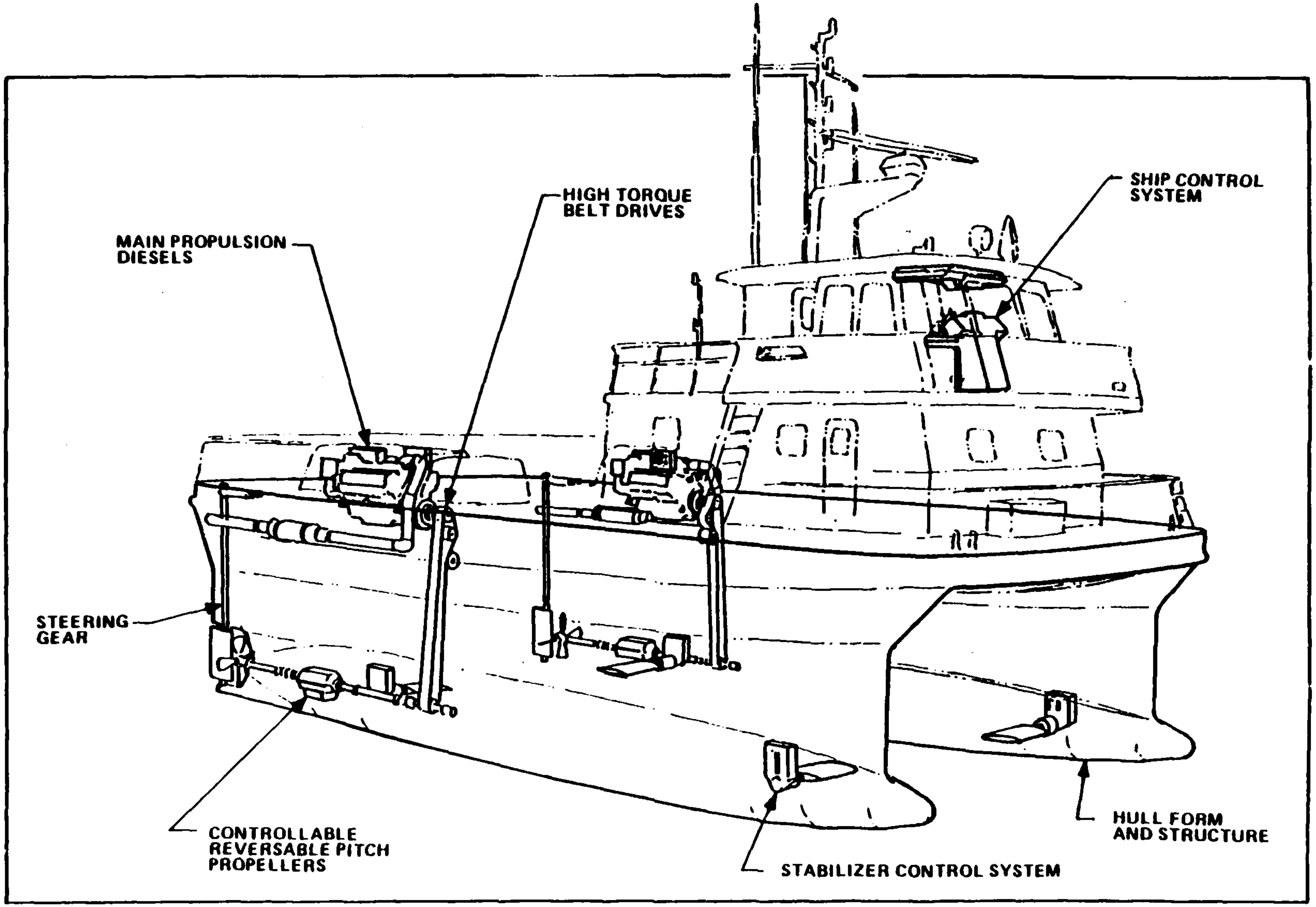


FIGURE 1. Key Design Elements of the HALCYON (from Reference 1)

TABLE I

PRINCIPAL CHARACTERISTICS

Design

Length Overall	60 ft.
Maximum Beam	30 ft.
Navigational Draft (Nominal)	7 ft. 2 in.
* Full Load Displacement (Design)	57 long tons
Light Ship Displacement	43 long tons
Available Cargo Deck Area	589 ft^2

All marine grade aluminum construction, double sided continuous welds. Sixteen watertight compartments in cross structure, 16 in each strut, 7 in each lower hull.

Payload (Typical)

Passengers	20
Cargo	5.25 long tons

Fuel (100%)

Main Deck Gravity Service Tank	58 gal.
Four tanks in Lower Hulls	(2) - 810 gal. ea.
	(2) - 420 gal. ea.
	TOTAL 2,518 gal.

Water and Sanitary Systems

Village Marine, Reverse Osmosis	350 gal./day
Fresh Water Holding Tank	300 gal.
1 Head w/Shower & Sink.	
Galley Sink, Bridge Sink	
Sanitary System w/Holding tank	

Bridge

Layout shown in Figure 2	250 ft^2

* Topping off all fuel and water tanks will put the vessel at approximately 68 LT with a draft of 8.5 feet. At this draft there is 3.0 feet between the waterline and wet deck. In the construction process they went to thicker plating than specified when the specified plating was not in stock. This resulted in a heavier displacement than designed.

TABLE I (cont'd)

Outfit (See Figure 3)

Galley (seating for 6) (Refrigerator, Freezer, Dry Stores, Microwave Oven)	132 ft^2
Head (Sink, Shower, Water Closet)	37 ft^2
Berthing (2 bunks)	63 ft^2
Payload/Berthing (unfinished)	200 ft^2

Anchor

90 lb. Danforth
400 ft. 1/2 in. diameter Chain
Lighthouse Marine Windlass 1.200 lb. pull, 65 ft./min.

Corrosion Protection

"Electro-Guard" Cathodic Impressed Current System with High Purity Aluminum Alloy Sacrificial Anodes.

Trim and Ballast System

Seawater Ballast Tanks (2 in each lower side hull and 1 in aft area of the strut)	6 (3 per side)
Ballast Pumps	120 gal./min. at 65 psi
Pilot House Tank Level Readouts	
Pilot House Bilge Alarm	

Weight Group

	weight (LT)
100 - Hull Structure	24.9
200 - Propulsion Plant	10.0
300 - Electric Plant	3.7
400 - Command & Surveillance	0.4
500 - Auxiliary Systems	3.8
600 - Outfit & Furnishings	4.7
Lightship Weight	46.3
FOO - Variable Load	
Operating Fluids	1.0
Payload (fuel, crew, FW, etc.)	9.5
Full Load Displacement at 7 ft. draft	57.0

TABLE I (cont'd)

Ride Control System

4 Control Surfaces:	$\pm 25^{\circ}$ each
Forward Canards (2)	6.25 sq. ft. ea.
Aft Stabilizers (2)	16.0 sq. ft. ea.
Computer Controlled and Manual Override	Analog Devices MACSYM 150 Microprocessor
Electro-Hydraulic Servosystem	
Sensors 1) Speed Log	
2) Roll & Pitch Angle Gyro	
3) 2 Accelerometers (heave & sway)	

Stability (Light Ship)

Center of Gravity (CG)	.47 ft. aft amidships, 12.06 ft. above baseline
Metacentric Height (GM)	4.69 ft.

Crew	3

Speed

Maximum (calm water)	21 knots
Cruise (tested in 7-8 ft. seas)	18 knots

Cruise Range

Payload (Typical) and No Fuel Reserve (at 18 Knots)	986 nm

Machinery

Propulsion Plant - 2 Caterpillar 3408 DI-TA, 510 Hp ea. at 2100 rpm, Marine diesels with reduction gear, Eaton V-belts, 45-inch diameter, Hundested VP9 FR-H hydraulic controllable reversible pitch propellers, (see Figure 5).

Electric Plant - 2 (25 KW) Perkins marine diesel generator sets

Stabilizer System - Koopnautic hydraulic actuators and control surfaces, Moog servo valves and control electronics, analog devices, MACSYM150 microprocessor.

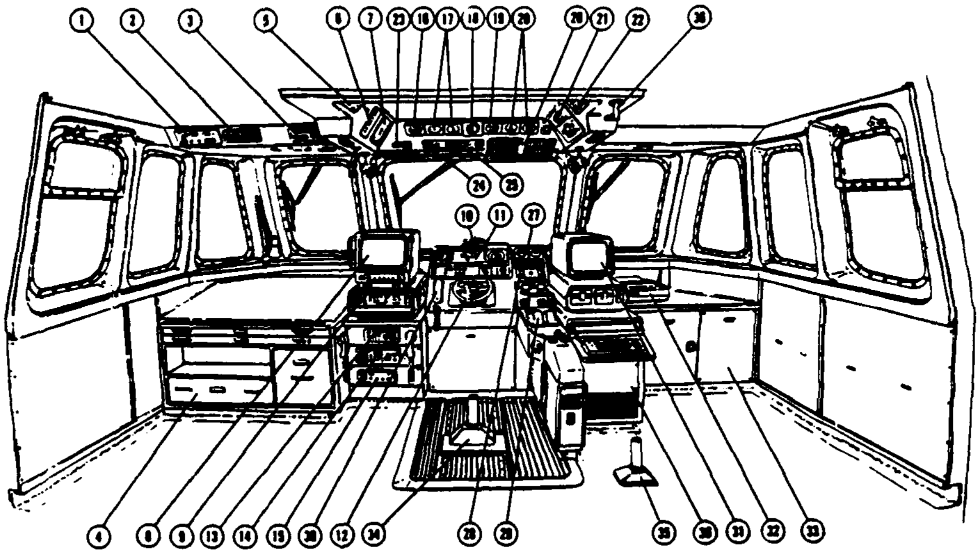
Deck Machinery - H1AB 60 deck crane, controlled from pilot house aft deck. Maximum lift 1,980 lbs. at 20 ft. 4 in. Can be used for deploying & retrieving a Rigid Hull Inflatable off either beam.

structure with chain drive to the pods below, while the HALCYON is powered by two diesels on the main deck with vee belt drives to the pods. The HALCYON has fully reversible controllable pitch propellers while the KAIMALINO once had them; they are now fixed pitch. The KAIMALINO is large enough to take advantage of the depth of the cross structure where machinery and living spaces exist. The 2-1/2 foot depth of the HALCYON's cross structure is used to some extent by allowing the placement of the two main engines and 25 KW generators to be recessed into the deck.

The open engine configuration on the main deck of the HALCYON coupled with a well-placed articulated hydraulic crane at the centerline has several advantages. The engine, belt drives and generators are easily accessible from the main deck for maintenance purposes. The crane allows movement of heavy engine and drive train components with ease. A drive train belt can be replaced by two people using the crane with sound powered head phones for communication. The bridge is very large (250 ft^2) and outfitted with state-of-the-art electronic navigation, ride control system, radio and digital radar systems, as seen in Figure 2. There is excellent visibility in all directions and the vessel can be controlled from the cabin and both bridge wings. The mess deck can accommodate six people and there is refrigerated and dry storage space for approximately 5 day's provisions. The berthing space is set up with two racks. An unfinished passenger/berthing space has floor space of 200 square feet (Figure 3).

TESTS CONDUCTED

The objective of the technical evaluation of the HALCYON is to quantify the power plant performance, maneuvering, stability, and seakeeping capabilities of this relatively small SWATH ship. In order to do this, we conducted the following tests in accordance with the USCG R&D Ship General Test Plan (GTP), Reference 3. The following list is an outline of the tests completed.



1. FURUNO LC-90, LORAN C RECEIVER/NAVIGATOR
2. FURUNO AVAD 10, A/D
3. TAIYO TD-L1100 AUTOMATIC DIRECTION FINDER
4. CHART TABLE WITH STORAGE/FILE CABINET BELOW
5. STABILIZER CONTROL SYSTEM LOCAL CONTROL PANEL
6. LIGHTING SWITCH PANEL
7. AQUA SIGNAL NAVIGATION LIGHT PANEL
8. FURUNO FCR-1411/6, 72 NM COLOR RADAR DISPLAY
9. FURUNO GD 2000 NAVIGATION COMPUTER
10. SAURA 5" MAGNETIC COMPASS
11. ANSCHUETZ COMPILOT 5 CONSOLE
12. ANSCHUETZ FOLLOW-UP ELECTRIC HELM
13. ICOM M-80 VHF/FM TRANSCEIVER
14. ICOM M-700 HF/SSB TRANSCEIVER
15. RAYTHEON RAY-400 LOUDHAILER
16. VDO MARINE CLOCK
17. DATA MARINE LX 360 WIND SPEED AND DIRECTION DISPLAY
18. VDO RUDDER ANGLE INDICATOR
19. HORIZON DEPTH SOUNDER
20. DECCA EMY 1/C ELECTROMAGNETIC SPEED LOG
21. BALLAST/TRIM SYSTEM CONTROL PANEL
22. FUEL SYSTEM CONTROL PANEL
23. SWITCH PANEL
24. ALARM ANNUNCIATOR
25. ALARM INDICATOR PANEL
26. PROPULSION PLANT INSTRUMENT PANEL NO. 1
27. PROPULSION PLANT INSTRUMENT PANEL NO. 2
28. DIESEL ENGINE START/STOP SWITCH PANEL
29. DIESEL ENGINE AND CONTROLLABLE REVERSABLE PITCH PROPELLER-THROTTLE AND PITCH COMMAND AIR CONTROLLERS
30. MECO-AIPHONE INTERCOM PHONE
31. ANALOG DEVICES MAC SYM 150 MICROPROCESSOR AND DISPLAY
32. EPSON PRINTER
33. STORAGE CABINET
34. HELM PILOTS CHAIR AND DECK RAIL ASSEMBLY
35. STABILIZER CONTROL SYSTEM ENGINEERS CHAIR
36. STABILIZER CONTROL SYSTEM ELECTRONICS CABINET

NOT SHOWN: ANSCHUETZ "GYROSTAR" GYRO COMPASS, NAV-AID 2002 AUTOPILOT-LORAN C INTERFACE AND STABILIZER CONTROL SYSTEM VERTICAL GYRO (PITCH/ROLL)/ACCELEROMETER (SWAY/HEAVE) UNIT.

FIGURE 2. Bridge Control Station (from Reference 6)

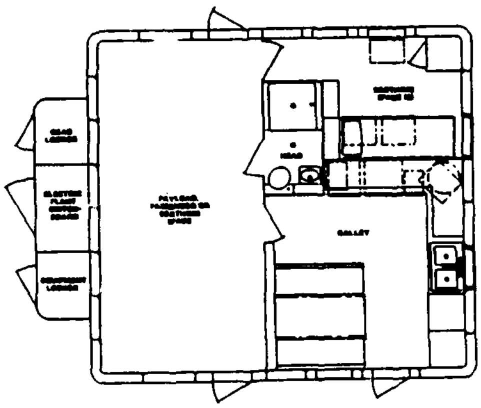


FIGURE 3. Main Deckhouse (from Reference 6)

Test	GTP No.	Comments
Seakeeping	13	Tested in 7.4-foot significant unidirectional seas at 17.5 knots at five headings with ride control system on. Tested dead-in-the-water head and beam seas. Humphries ship motion package placed at the center of gravity (CG). Roll angle, pitch angle, roll rate, pitch rate, inertial reference heave, surge and sway measurements made. Hull-mounted vertical accelerometers were placed on the bridge and mess deck.
Speed vs Horsepower	3	Shaft horsepower measured on shafts in submerged pods using strain gauges and an FM telemetry system (ACUREX HP meters).
Speed vs Fuel Consumption	4	HALDA Marine fuel flow measurement system was used. The displacement piston sensor measures the make-up fuel to a closed circulation loop on the diesel.
Tactical Data	7	Turning diameters, advance and transfer data were collected at 5.2, 9.8 and 18 knots using a RAYNAV 750 Loran receiver and Hewlett-Packard computer acquisition and position display system.
Maneuvering	8 and 9	Zig-zag tests were conducted at 10 and 17 knots. Spiral tests were completed at 8 and 14.5 knots.
Bollard Pull	5	Maximum towline tension of 19,700 lbs. was achieved with 2000 engine rpm with 50% pitch.
Towing at Sea	5	The 82' CGC *POINT BROWER* was towed at full power with a maximum speed of 12.1 knots and 7,300 lbs. tension on 3/4" wire rope.
Human Response to Motion	37	The Bruel & Kjaer human response vibration meter was used during seakeeping tests on the bridge.
Noise Levels	24	A&C weighted measurements were recorded throughout the ship. Permanent acoustic engine and generator covers are not installed yet so noise levels were a problem on the main deck aft.

Test	GTP No.	Comments
Moment to Heel	12	Inclining and stability test data were collected by RMI on 26 July 1985. Data are presented in Appendix D.

DATA COLLECTION

Tests were conducted and all data were analyzed by U.S. Coast Guard Research and Development Center personnel. RMI, Inc. provided the HALCYON, a pilot, one crew member, and all required fuel oil supplies in a cooperative testing effort in exchange for performance data of their vessel. All data with the exception of stability data were collected during nine underway days between 23 October and 3 November 1985 in the Greater San Diego area.

A Hewlett-Packard computer data acquisition system was installed aboard the HALCYON in the unfinished passenger space on the main deck. A 14 channel analog tape recorder was used for backup. The equipment setup is shown in Figure 4. A Humphries, Inc. ship motion package which measures all nine degrees of freedom motions was placed on the main deck at the center of gravity. Additional vertical accelerometers were body mounted on the bridge and in the mess deck, as seen in Figure 6. Sea state was measured using an Endeco 956 wave track directional wave buoy deployed before and after the seakeeping tests. Vertical accelerations were also measured on the bridge and processed using a Bruel & Kjaer (B&K) Human Response Meter. Shaft horsepower was measured with torque strain gauges applied to the lower pod shafts, as seen in Figure 5. An Acurex FM telemetry system was used to retrieve the torque signals and compute horsepower. Fuel flow meters were installed on both main engines with digital readout repeaters in the data collection area. A Raynav 750 Loran receiver was interfaced with the data acquisition computer to collect ship position data during turning diameter tests. Sound level measurements were conducted using a hand held B&K meter. The detailed description of all sensors is listed in Appendix A.

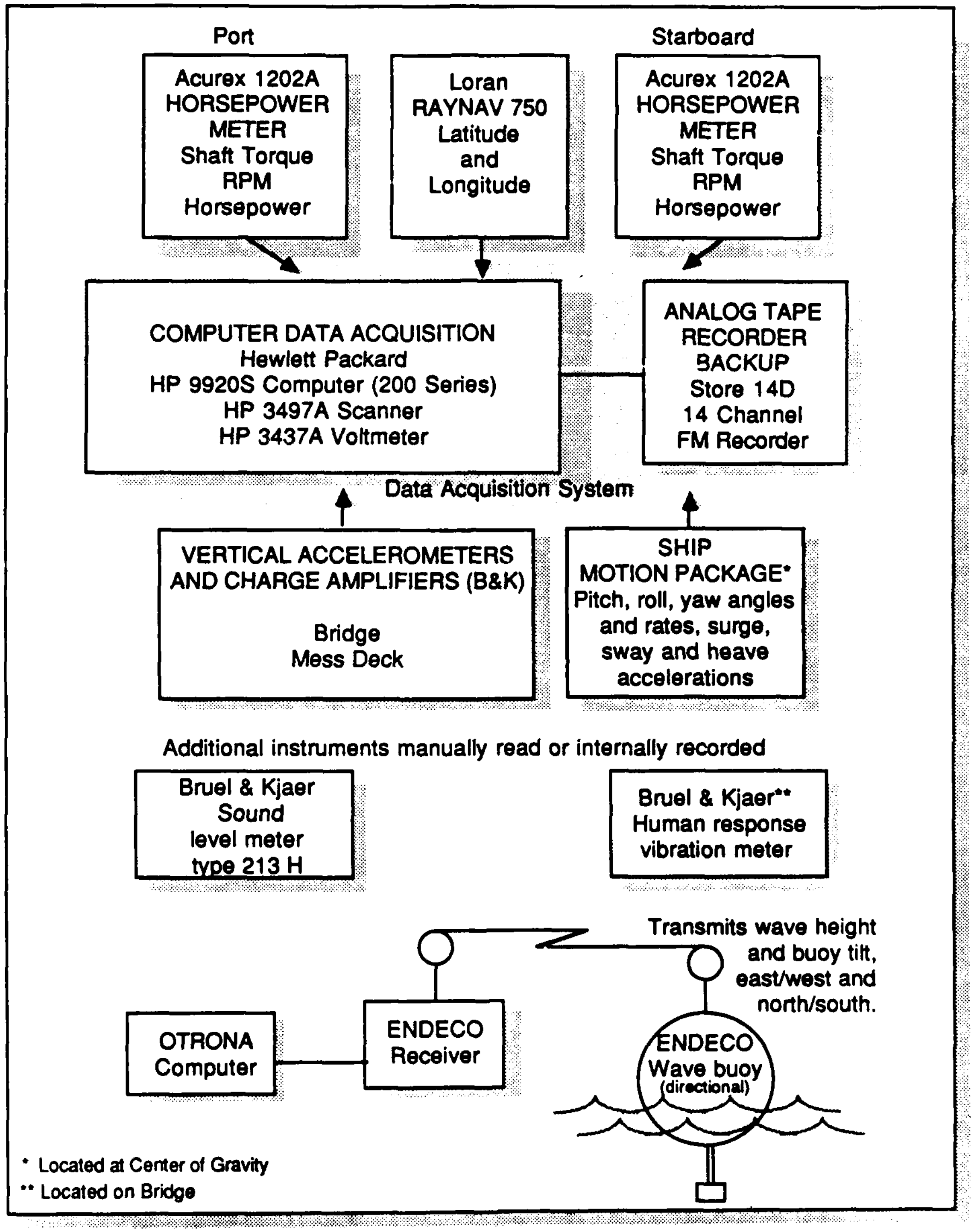


FIGURE 4. Block Diagram of Data Acquisition System

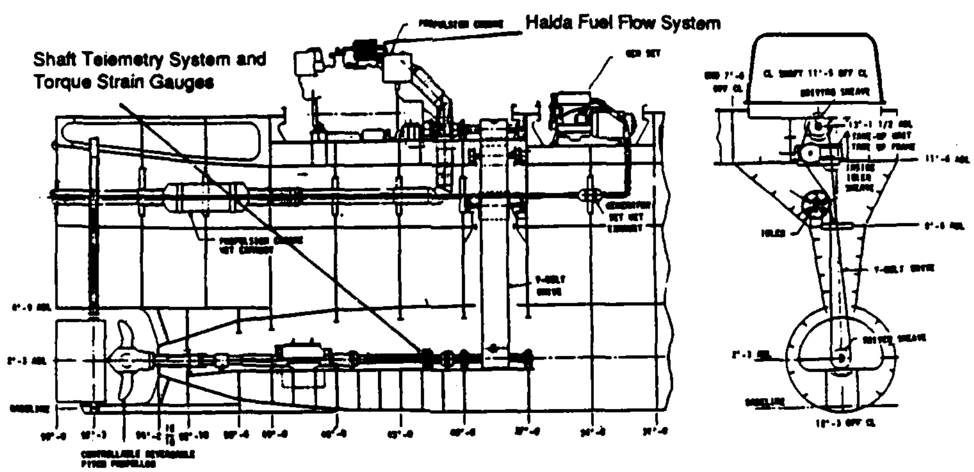


FIGURE 5. Machinery Arrangement and Shaft HP Measurement (from reference 6)

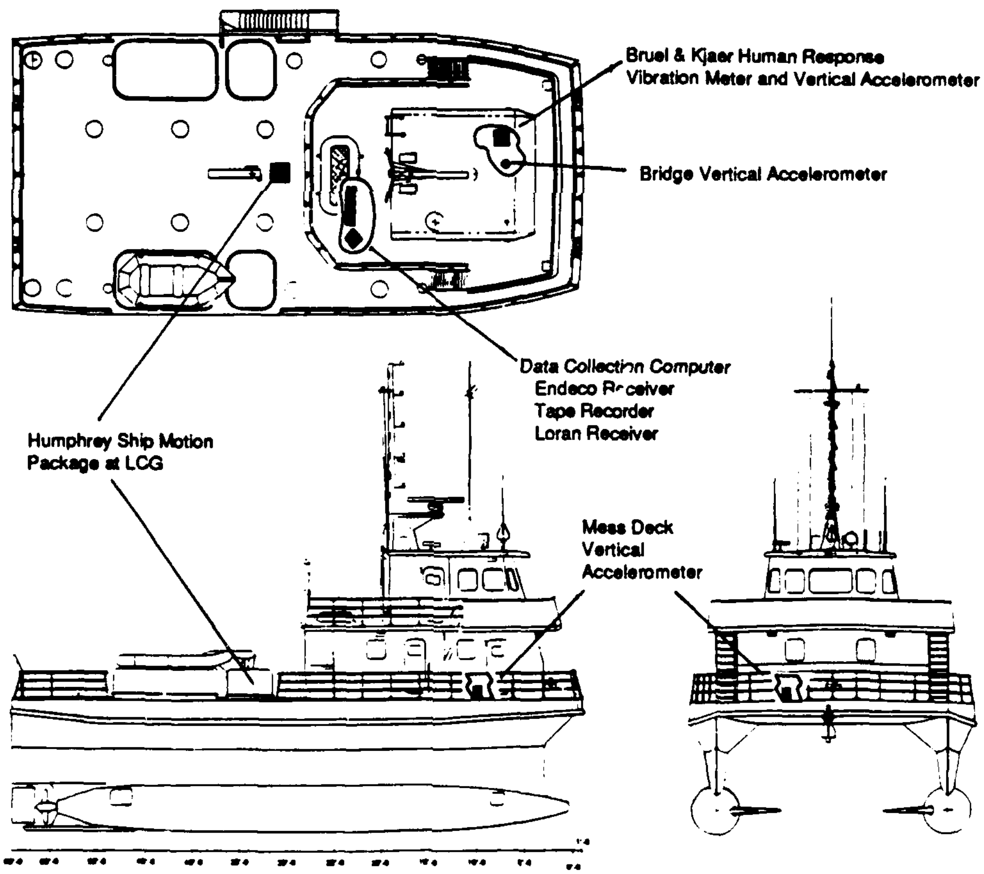


FIGURE 6. Sensor Locations (from Reference 6)

TEST RESULTS

Seakeeping

In order to get the highest sea state possible, we cruised 80 miles due west of San Diego to get northeast storm swells coming from Northern California gales. The Endeco directional wave buoy was deployed before and after the three hour test. There was no significant change in the unidirectional 7.4 ft. significant seas during the test. The wave power spectral density (PSD) plot, directional wave energy numbers and 3D directional wave plots are presented in Figures 7 through 9. Directional wave energy shown in Figure 8 in the frequency domain is plotted in the wave period domain in Figure 9. It is very clear that a true unidirectional sea was present during the tests. Wave PSD information is presented in table form in Appendix C, Table C-I. The seakeeping tests consisted of cruising at 17.5 knots in five headings relative to the major swells (head, bow, beam, quarter, and following seas) with the RCS on. Two motion tests dead-in-the-water (DIW) at head and beam orientations maintained by engine control were conducted with RCS off. One seakeeping test was conducted while maneuvering to retrieve the wave buoy at 0 to 3 knots at various orientations to the swell with RCS off.

While heading into the 7-8 foot seas, the very tops of some waves would impact the bottom of the cross box structure (wet deck) approximately 20 feet aft of the bow. This occurred about once every four minutes; however, there was no slamming, jolting, or significant surge experienced. The wave contact aft of the bow can be attributed to an average trim of 5 degrees up by the bow maintained by the ride control system. This trim coupled with the side strut wakes converging under the cross structure about 20 feet aft of the leading edge, added to the passing wave amplitude allowing occasional wave encounters against the wet deck. While observing from the main deck at the bow, it was an uncanny experience to see seven to eight foot waves passing

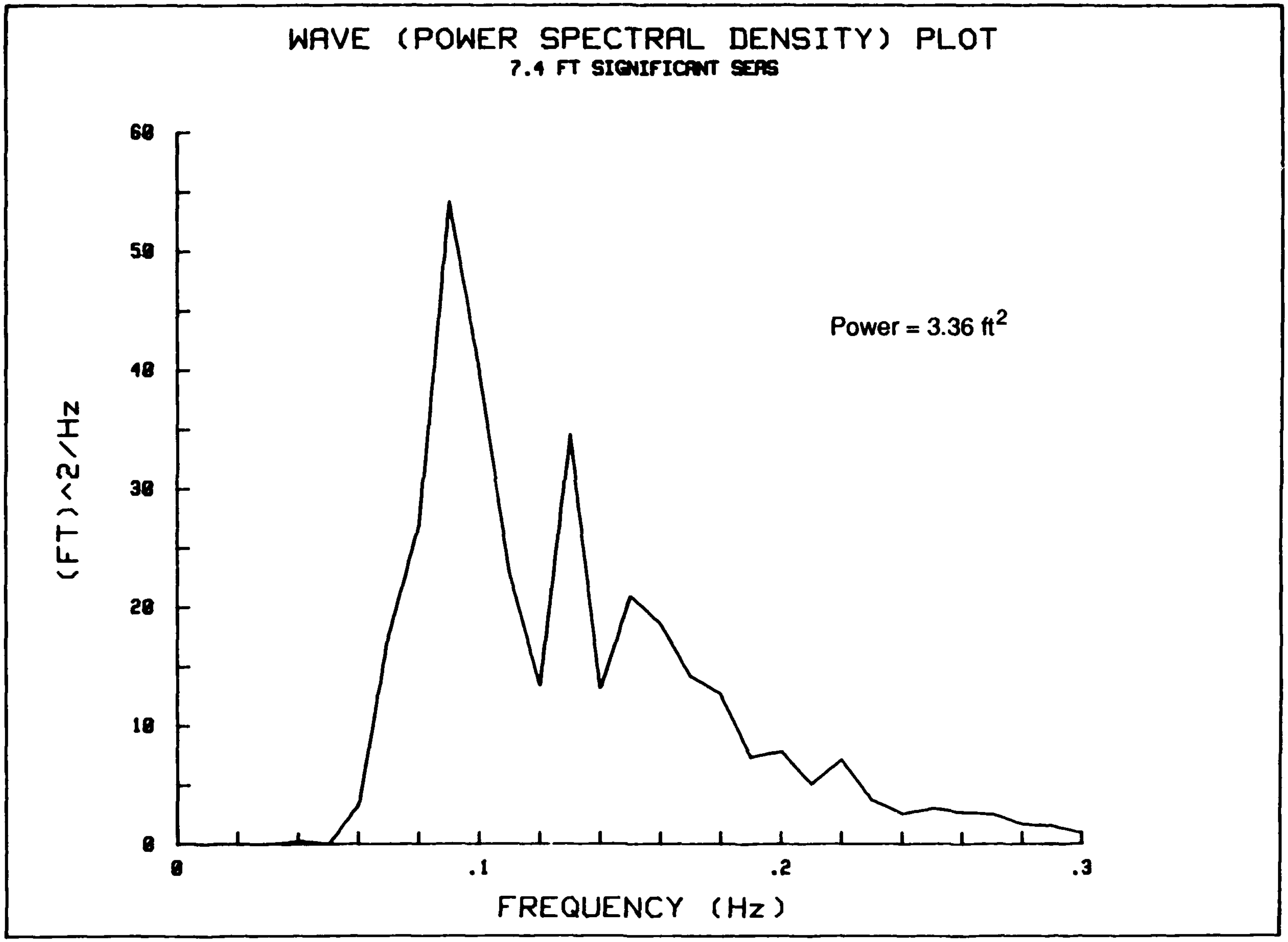


FIGURE 7. Wave PSD Plot

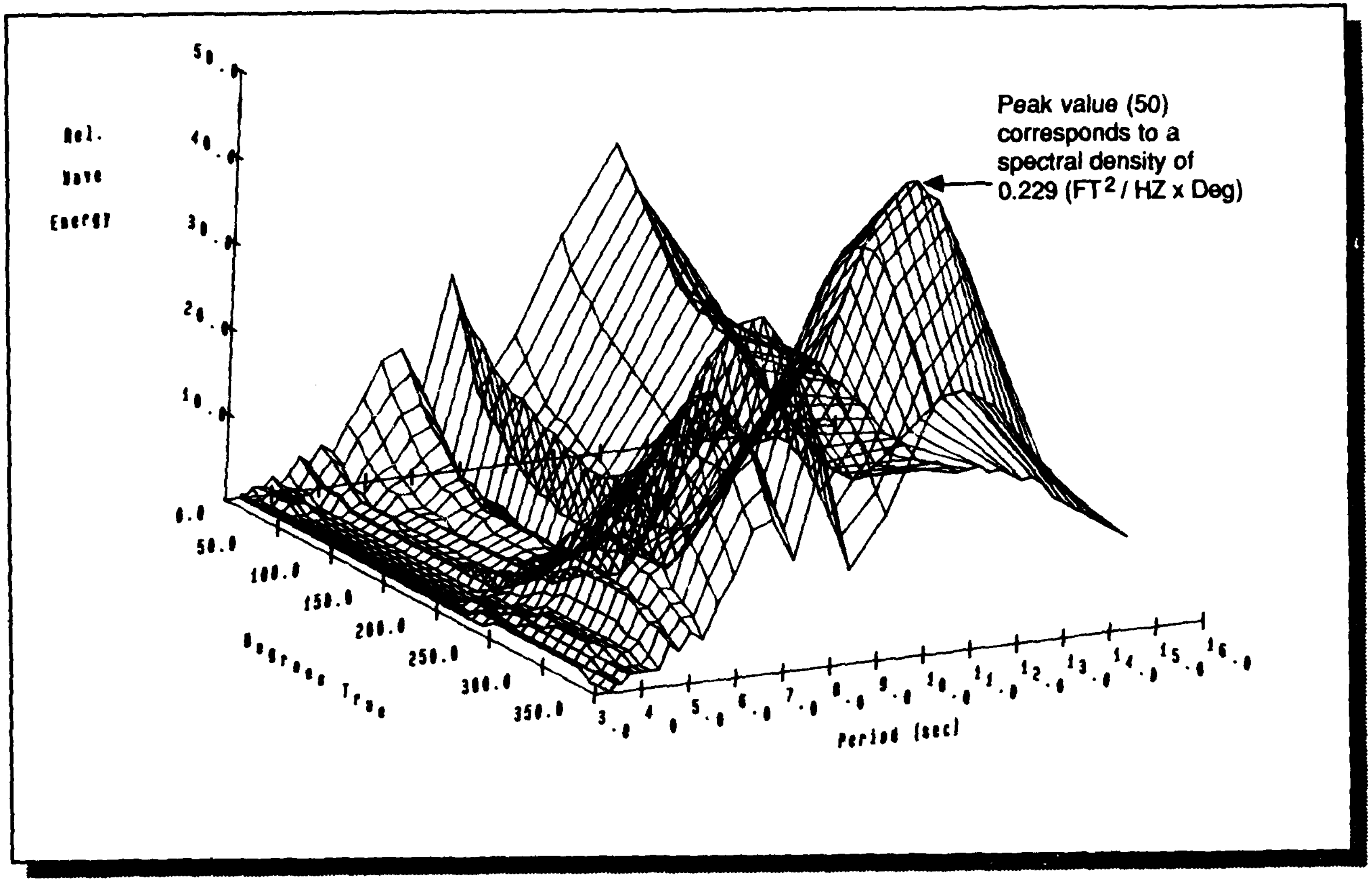
QUICK-LOOK PLOT OF FREQUENCY/DIRECTION SPECTRUM
ENTRIES ARE SCALED LINEARLY FROM 0 TO 50
PEAK VALUE CORRESPONDS TO SPECTRAL DENSITY OF .229 (FT-SQ/HZ/DEG)

Direction (Degrees True)	.03	.04	.05	.06	.07	.08	.09	.10	.11	.12	.13	.14	.15	.16	.17	.18	.19	.20	.21	.22	.23	.24	.25	.26	.27	.28	.29	.30
0	.	.	.	1	11	19	36	26	15	9	23	10	15	14	10	7	4	5	3	4	2	1	2	1	1	1	.	.
10	.	.	.	2	11	18	34	23	13	7	20	8	13	11	8	6	3	4	2	3	1	1	1	1	1	.	.	.
20	.	.	.	2	12	17	32	21	11	6	18	6	10	9	6	4	1	3	1	2	1	1	1	1	1	.	.	.
30	.	.	.	2	12	17	31	20	9	4	17	4	8	7	4	3	1	2	1	2	.	.	1	1	1	.	.	.
40	.	.	.	2	12	16	30	18	8	3	15	2	7	5	3	2	.	1	.	2	.	.	1	.	.	.	.	.
50	.	.	.	2	12	16	29	17	8	2	14	1	5	4	2	2	.	1	.	1	.	.	.	.	.	.	.	.
60	.	.	.	2	12	15	28	16	7	1	13	.	4	3	1	1	.	1	.	1	.	.	.	.	.	.	.	.
70	.	.	.	2	11	15	27	15	6	1	13	.	4	3	1	1	.	1	.	1	.	.	.	.	.	.	.	.
80	.	.	.	2	11	14	25	14	6	.	12	.	3	2	1	1	.	.	.	1	.	.	.	.	.	.	.	.
90	.	.	.	2	10	12	24	13	5	.	11	.	3	2	.	1	.	.	.	1	.	.	.	.	.	.	.	.
100	.	.	.	2	10	11	22	12	4	.	11	.	3	2	.	1	.	.	.	1	.	.	.	.	.	.	.	.
110	.	.	.	2	9	10	21	11	3	.	10	.	2	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.
120	.	.	.	1	8	9	20	10	3	.	10	.	2	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.
130	.	.	.	1	8	8	18	9	2	.	9	.	2	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.
140	.	.	.	1	8	7	18	9	2	.	9	.	1	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.
150	.	.	.	1	7	7	17	9	2	.	9	.	1	1	.	1	.	1	.	1	.	.	.	.	.	.	.	.
160	.	.	.	1	7	7	18	9	3	.	10	.	2	1	.	2	.	1	.	2	.	.	.	.	.	.	.	.
170	.	.	.	1	8	7	19	11	4	.	11	.	2	2	1	2	.	1	.	2	.	.	.	.	.	.	.	.
180	.	.	.	1	8	8	21	13	5	.	12	.	4	3	2	3	1	2	.	2	.	.	.	.	.	.	.	.
190	.	.	.	1	8	10	23	16	8	2	14	1	5	4	3	4	2	2	1	3	1	.	.	.	.	.	.	.
200	.	.	.	1	9	12	27	19	10	4	16	3	7	6	5	6	3	3	2	3	1	1	1	1	1	.	.	.
210	.	.	.	2	10	14	30	23	13	7	19	6	10	9	7	8	5	4	3	4	2	1	1	1	1	.	.	.
220	.	.	.	2	10	16	34	27	16	10	22	9	13	11	9	9	6	5	4	5	2	1	1	1	1	1	1	.
230	.	.	.	2	11	18	38	31	20	13	26	12	16	14	12	11	7	7	4	6	3	2	2	2	1	1	1	.
240	.	.	.	2	11	20	42	35	23	16	29	15	19	17	14	13	9	9	5	6	4	2	2	2	2	1	1	1
250	.	.	.	2	11	22	45	38	25	18	31	18	22	20	17	15	10	9	6	7	4	3	2	2	2	1	1	1
260	.	.	.	1	12	23	47	41	27	20	34	21	25	22	18	16	11	10	7	8	5	3	3	3	2	2	1	1
270	.	.	.	1	12	24	49	42	29	21	35	22	27	24	20	17	12	10	9	8	5	3	3	3	2	2	1	1
280	.	.	.	1	11	24	50	43	29	22	36	24	28	26	21	18	12	11	8	8	5	3	3	3	3	2	1	1
290	.	.	.	1	11	24	49	43	29	22	37	24	29	26	21	17	12	11	8	3	5	3	3	3	3	2	1	1
300	.	.	.	1	11	24	49	42	28	21	34	24	28	26	21	17	11	10	9	9	5	3	3	3	3	2	1	1
310	.	.	.	1	11	23	47	40	26	20	35	22	27	25	20	16	11	10	7	9	5	3	3	3	3	2	1	1
320	.	.	.	1	11	22	45	37	24	18	33	21	26	24	19	15	9	9	7	7	4	3	3	3	2	2	1	1
330	.	.	.	1	11	21	43	35	22	16	31	18	24	22	17	13	9	8	6	6	4	3	3	2	2	1	1	.
340	.	.	.	1	11	20	40	32	19	14	28	16	21	19	15	11	7	7	5	6	3	2	2	2	2	1	1	.
350	.	.	.	1	11	19	38	29	17	11	25	13	18	17	12	9	5	6	4	5	2	2	2	2	2	1	1	.

Frequency (HZ)

Significant wave height of 7.4 feet during HALCYON seakeeping tests

FIGURE 8. Frequency / Direction Wave Energy Spectrum



Sea State During HALCYON Seakeeping Test
Significant Wave Height 7.4 feet

FIGURE 9. 3D Period / Direction Wave Energy Plot

underneath you. The anticipated reaction was to hold on to the rail for the impact, but the wave would pass as though it did not exist. The name HALCYON, a bird held in ancient legend to calm the seas, is a good choice for this vessel. No bow spray or bow impacts were observed during the nine hour transit to and from the seakeeping test area or during the three hour seakeeping tests.

Roll and pitch angles, rates, and vertically stabilized heave surge and sway accelerations were measured at the center of gravity. Vertical accelerations were also measured in the mess deck and at the steering station of the bridge, Figure 6, during each 15-17 minute seakeeping run. All data was digitized by the Hewlett-Packard data acquisition system at a rate of 3 Hz. Motion data was analyzed on board while returning to port. The data analysis program BATCH searches the digital file of each channel record for peaks off the mean signal level (baseline) which exceeds a defined limit (epsilon). All peaks for the entire seakeeping leg run are sorted from high to low. Subsequently, highest peak, average of the 1/10th highest values (H 1/10), average of the 1/3rd highest values (H 1/3), RMS, and mean values are calculated. These are all single amplitude motions.

The wave field was measured before and after the three hour seakeeping evaluation using an ENDECO 56 directional wave buoy. There was no change in the sea state during the test in 7.4 foot significant waves. The wave field power spectral density (PSD) plot is presented in Figure 7. It can be seen in Figure 8 that the seas are fairly unidirectional with most of the energy concentrated at 280° true at a frequency of 0.09 Hz or 11 second period wave. This data converted to wave period form is plotted 3D in Figure 9 in order to graphically show the wave energy field in which the HALCYON was tested.

The tabulated results of all seakeeping tests are presented in Tables B-I and B-II. Selected significant (H 1/3) roll, pitch, and heave data at 17.5 knot runs with RCS on are plotted in polar form in Figures 10 through 12. It can be seen in Figure 10 that roll amplitudes are extremely low, all below 1.5 degrees, and only slightly higher in beam, stern quarter and following seas compared to head seas. The RCS is very effective in reducing pitch in head and bow seas, with diminished effect in quartering and following seas (Figure 11).

Heave acceleration is very low at the center of gravity (CG) for this size ship in 7.4 significant seas. Head and bow seas produce the same heave response (0.125 G's) while significant reduction is accomplished in quartering and following seas as seen in Figure 12. In comparison to larger displacement and planing craft tested in lower sea states, 0.30 G's heave was measured at the CG on a 95' patrol boat (WPB) in 4.5 ft. significant head seas proceeding at 19 knots, and 0.18 G's heave was measured on an 82' WPB in only 3 ft. head seas at 16 knots (Reference 4). Heave measurements on the new Coast Guard planing boat, the 110' Island Class WPB, were 0.43 G's in 6 ft. head seas proceeding at 21 knots, Reference 5. The larger SWATH ship SSP KAIMALINO, 3.7 times heavier in displacement than the HALCYON, had much lower vertical accelerations in 10 ft. head seas proceeding at 8 knots with only 0.04 G's measured (Reference 2).

Vertical accelerations encountered at the longitudinal center of gravity (LCG), mess deck, and bridge are plotted in bar chart form in Figure 13 for head, bow, beam, and following seas at 17.5 knots. The significant heave accelerations measured on the bridge in head seas were 0.145 G's, only 14% higher than that measured at the LCG (0.125 G's). The bridge sensor was 26 feet forward of the LCG. This is a very low increase of acceleration from the LCG to bridge compared to measurements conducted on conventional displacement vessels and surface effect ships (SES). The percent increase of vertical accelerations from the LCG to

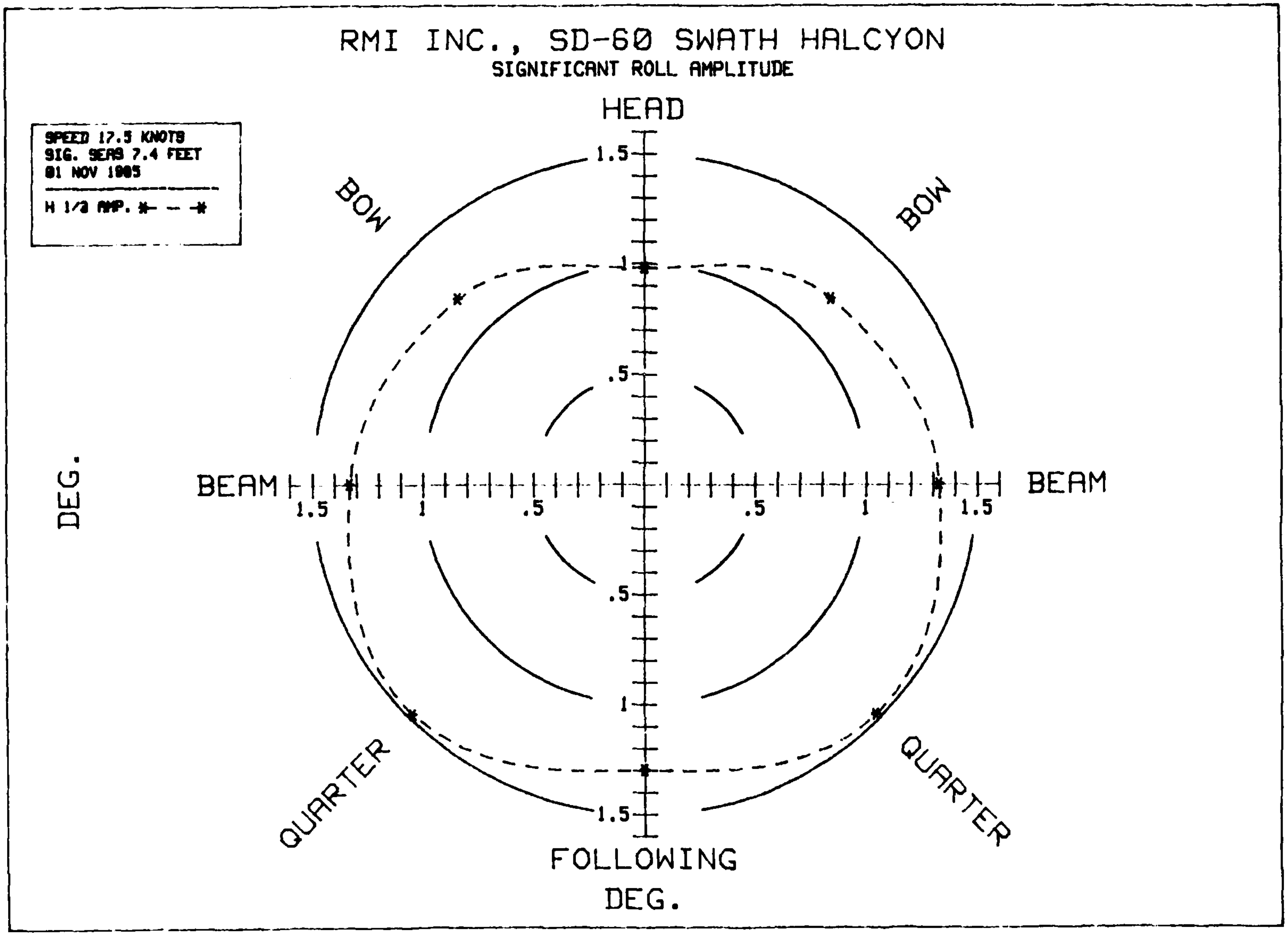


FIGURE 10. Roll Amplitude Polar Plot

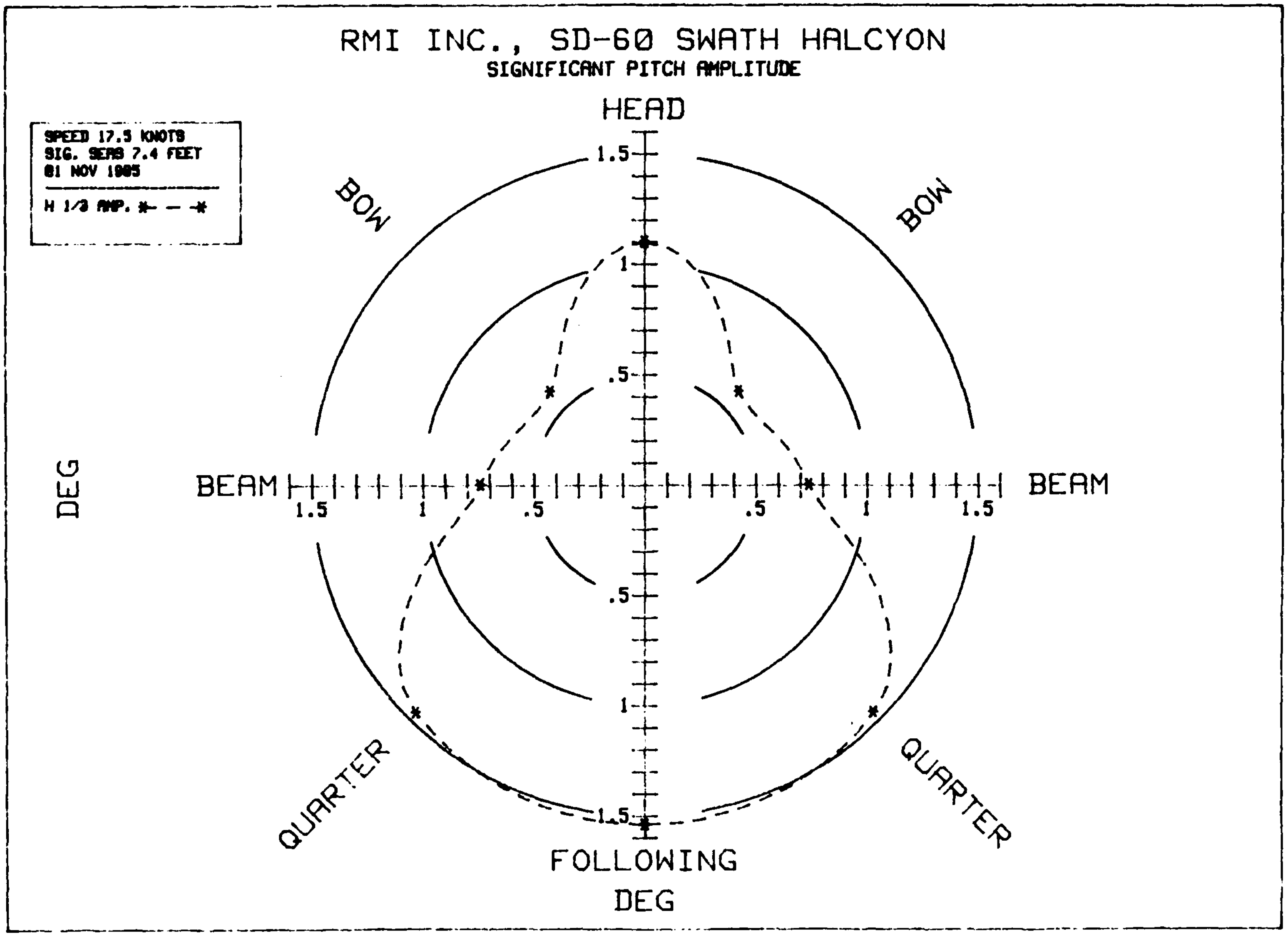


FIGURE 11. Pitch Amplitude Polar Plot

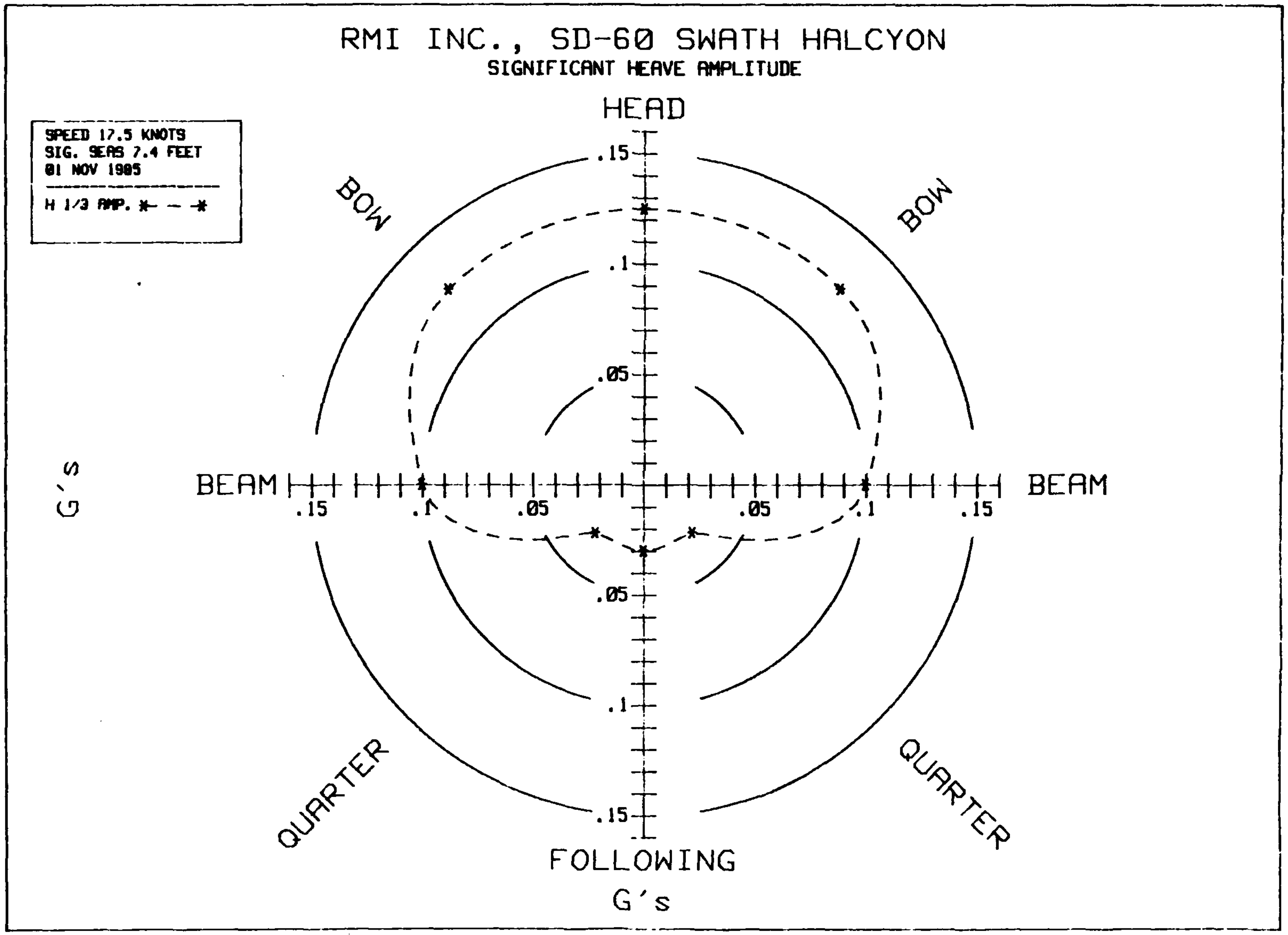


FIGURE 12. Heave Amplitude Polar Plot at CG

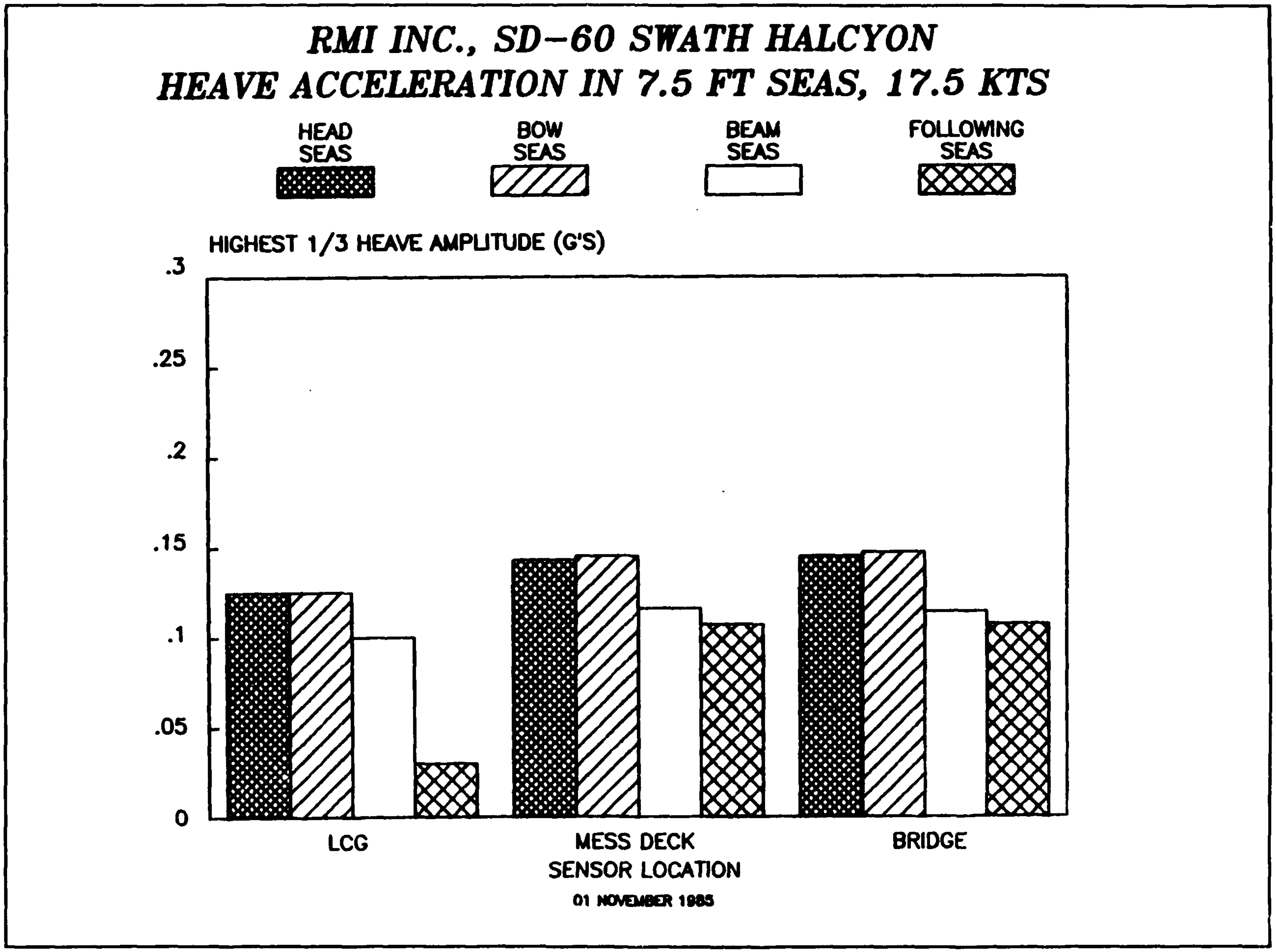


FIGURE 13. Heave Amplitude by Location Aboard Ship

the bridge on the 110' Island Class (WPB) was 25%, while a 37% heave increase was measured on the 110' SES. This ride quality is attributable to the SWATH design and reduced pitch response due to the active fin ride control system.

The HALCYON continues to be a very good seakeeping platform while dead in the water or maneuvering at slow (0-3 knots) speed with the ride control system off. This is seen in Table B-II where significant roll amplitudes were 2.6 to 6.1 degrees and significant pitch amplitude was 2.3 to 3.8 degrees during at rest and low speed maneuvering in 7.2 ft seas. Significant heave accelerations were very low, all below 0.11 G's at the CG. The HALCYON maneuvered effortlessly in the dark at slow speeds without regard to major swell directions to deploy and retrieve the Endeco directional wave buoy. This motion data and buoy operations experience indicates that small boat operations in 7-8 foot seas would be conducted very easily even at night with deck lighting.

Human Response - Motion Sickness

Table II catalogs the measurement of human response to vertical heave on the bridge of the HALCYON. The B&K human response meter uses International Standards Organization (ISO) Standard 2631 to predict human body reaction to whole body motion by measuring vertical accelerations. The relative indicator of discomfort is the time to reach 100% of the threshold limit. This is not an indication that 100% of the people on board will be sick, it generally is not. It is simply the point at which the ISO standard has been reached. In our experience, a significant portion of the ship's crew will be seasick if the 100% severe discomfort threshold is reached in 20 minutes or less. The shortest time in which the 100% severe discomfort threshold was reached was 114 minutes in 6 ft head seas proceeding at 18 knots. During the seakeeping runs, it was noted that two of the seven people aboard were seasick.

TABLE II. HALCYON Human Factors

ISO Motion Sickness Discomfort Standards

SHIP HEADING	TIME TO 100% EXPOSURE* Reduced Comfort	Severe Discomfort	PEAK HEAVE ACCELERATION (G)	EQUIVALENT HEAVE ACCELERATION LEQ (G)
1 NOV 85		4-6 FT SWELLS		SPEED 18 KTS (Bridge)
HEAD	N/A	114 min.	.10	.05
BOW QUARTER	5 min.	120 min.	.22	.08
BEAM	N/A	232 min.	.19	.03
QUARTER	N/A	unlimited	.04	.03
FOLLOWING	N/A	unlimited	.04	.03
1 NOV 1985		4-6 FT SWELLS		DIW (Bridge)
HEAD	N/A	263 min.	.10	.03
28 OCT 1985		3 FT SWELLS		SPEED 17 KTS (Bridge)
BOW QUARTER	8.9 min.	550 min.	.13	.06
VARIOUS	N/A	570 min.	.07	.02

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* This measurement made by the Bruel & Kjaer Human Response Vibration Meter is based upon vertical accelerations using International Standards Organization (ISO) Standard 2631.

Response Amplitude Operators (RAO)

The calculation and use of RAOs assumes certain environmental and response characteristics in order to be valid. The method is only valid for ship responses in an irregular unidirectional seaway only if the responses are linearly proportional to the wave excitation (i.e., the wave amplitude.) In general, any nonlinear ship response can be ignored in practice; thus, RAO techniques for characterization and prediction of ship responses are valid as long as a unidirectional sea state is available for testing. The Endeco 956 Wave Track buoy provides enough directional information to accurately identify a good unidirectonal sea state when available. This was the case during the HALCYON seakeeping test as seen in the 3D plot of directional wave energy (Figure 9).

Wave height is measured with a free floating wave buoy, while ship motions are measured by a ship motion package aboard the vessel. A wave spectrum PSD is obtained from Endeco software processing 20 minutes of wave data on an Otrona microcomputer.

Next, the wave spectrum is input into a WAV_ANL3 program which runs on a Hewlett-Packard (HP) 9920S computer. It is transformed into a spectrum where the frequency of encounter is considered instead of the absolute wave frequency. This conversion is based upon the vessel's speed and direction relative to the major swell direction (i.e., there would be no change for a vessel proceeding in beam seas at any speed.) The area under the modified spectrum is the same as that under the original spectrum, since the total energy remains the same. Assuming the wave energy is distributed in the form of a Rayleigh distribution, significant wave height is calculated by the formula

$$H\ 1/3 = 4\sqrt{\text{power}}$$

The ship motion record (i.e., roll, pitch, or heave) is also converted to a spectrum. The analog data collected on tape is analyzed by an HP 5420A digital signal analyzer and passed to the HP computer by the program. It is already at a frequency of encounter relation because the motions were measured aboard the vessel.

The RAO or transform spectrum is then calculated by dividing the motion amplitude spectrum by the wave amplitude encountered spectrum. The roll and pitch RAOs are non-dimensional representations of the vessel's response to wave encounters and heave RAOs are in units G^2Ft^2. Ship motions of the HALCYON in any other irregular unidirectional seaway can be calculated by multiplying the ordinates of the transformed wave spectrum by the ordinates of the RAO for the corresponding frequencies of encounters. Finally, the area under the motion amplitude spectrum is determined in order to obtain the necessary statistical motion characteristics (i.e., mean, H 1/3, H 1/10 motion amplitudes.) This assumes a Rayleigh distribution of the motions. The WAV_ANL3 program has this capability.

A ship motion comparison is presented here between the 60 LT SWATH HALCYON and the 62 LT semi-displacement 82' Coast Guard patrol boat (WPB) PT KNOLL. This is accomplished by using RAOs calculated from full-scale test data. The HALCYON's RAOs were calculated from data collected 1 November 1985 in 7.4 ft seas proceeding at 17.5 knots. PT KNOLL's RAOs are calculated from data collected 2 August 1983 in 2.8 ft seas proceeding at 16 knots. Roll, pitch and heave RAOs for head, bow quarter and beam sea runs calculated from those field tests are presented in Appendix C. The comparison between the vessels is analytically accomplished using the WAV_ANL3 program with RAOs calculated and by generating the desired wave spectra. The wave spectra chosen is representative of a typical winter offshore sea state found 70 miles southeast of Cape Cod, MA, (Reference 7). The wave spectra

chosen represents a 5 ft significant wave height with the majority of waves at a 6 second period as seen in Appendix C, Figure C-43. The sea state height chosen is midway between the wave heights in which both vessels were field tested. This spectra was generated by the program using a two-term ISSC modification to the Pierson-Moskowitz spectrum. The roll, pitch, and heave single amplitude motions for head, bow quarter and beam sea operations while proceeding at 17 knots in 5 ft seas were calculated for both vessels and are presented in Table III. Graphic and tabular data of the HALCYON and PT KNOLL's RAOs, motion spectra and wave spectra are presented in Appendix C.

A graphic comparison of significant (average of the highest 1/3 amplitudes) ship motions calculated for 5 ft sea operations at 17 knots using RAOs is presented in Figure 14. The 60 foot SWATH HALCYON has much lower significant roll, pitch and heave motions than the mono-hull 82 foot WPB PT KNOLL. The PT KNOLL has heave accelerations at the CG 4.9 times higher than the HALCYON in head seas (.34 vs .07 Gs). The PT KNOLL has pitch amplitudes 13 times larger than the HALCYON in bow quarter seas (3.39 vs 0.26 deg). PT KNOLL has seven times more roll motion than the HALCYON in 5 ft beam seas (7 vs 1 deg). The SWATH is relatively insensitive to the relative heading of the major swells while the PT KNOLL is very sensitive. Pitch and heave motions of both vessels are fairly close only in beam seas.

Maneuverability

The HALCYON has two variable pitch full reversing propellers located 24 ft apart on each submerged pod. This configuration along with bridge wing controls allowed the pilot to easily maneuver during docking and towing hand-off operations by using reverse thrust. While proceeding at 20 knots the vessel was stopped in approximately one ship length using full reverse pitch. This was an unplanned maneuver to avoid a large floating kelp pad.

COMPARISON OF SWATH HALCYON AND PT KNOLL SIGNIFICANT MOTIONS IN 5 FT SEAS, USING RAO CALCULATIONS. SPEED 17 KNOTS

SIGNIFICANT ROLL AMPLITUDE

SIGNIFICANT PITCH AMPLITUDE

SIGNIFICANT HEAVE AMPLITUDE

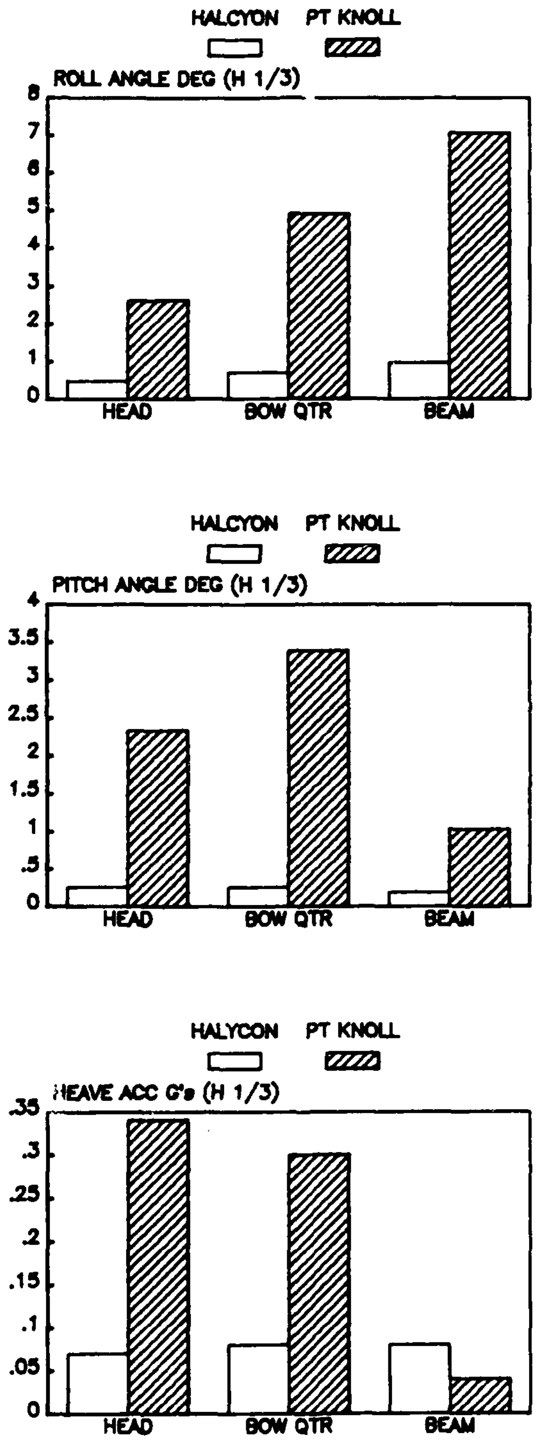

FIGURE 14. Graphic Comparison of HALCYON and PT KNOLL Seakeeping Performance

TABLE III

COMPARISON OF 82' WPB AND HALCYON MOTIONS USING RAO'S

PT KNOLL WPB originally tested in 2.8 ft seas, at 16 knots. Tested 2 August 1983

SWATH HALCYON originally tested in 7.4 ft seas, at 17.5 knots. Tested 1 November 1985

The comparison between the two ships was generated by the WAV_ANAL3 computer program using 5 ft, 6 second waves generated using the ISSC option.

SPEED 17 KNOTS

	HEAVE G's		PITCH Deg		ROLL Deg	
	PT KNOLL	HALYCON	PT KNOLL	HALYCON	PT KNOLL	HALYCON
HEAD SEAS						
H mean	.21	.04	1.46	.16	1.64	.30
H 1/3	.34	.07	2.33	.26	2.61	.48
H 1/10	.43	.08	2.97	.32	3.32	.61
BOW QTR SEAS						
H mean	.19	.05	2.11	.16	3.07	.50
H 1/3	.30	.08	3.38	.26	4.90	.70
H 1/10	.38	.11	4.30	.33	6.24	1.01
BEAM SEAS						
H mean	.03	.05	.64	.12	4.42	.60
H 1/3	.04	.08	1.02	.19	7.06	.97
H 1/10	.06	.10	1.30	.25	8.99	1.23

All motions are single amplitude.

Spiral Tests: Dieudonne spiral maneuvers and zig-zag (overshoot) maneuvers were conducted. The spiral tests are designed to measure the steady state yaw (turning) rates of the vessel as a function of rudder angle. A plot of these values is indicative of the course keeping stability characteristics of the ship. The yaw rate measurements at 8 and 14.5 knots are presented in Figure B-III. The spiral plots of this data are shown in Figures 15 and 16. The 0.5 deg./sec. yaw rate to port at 0 rudder angle was attributed to observed misalignment of the two rudders. At 14.5 knots, some hysteresis occurs near 0 yaw rate as seen in Figure 16. The HALCYON has an 8 knot yaw rate of 3.4 deg./sec. with 30° rudder compared to 1.4 deg./sec. yaw rate of the 89 foot SWATH KAIMALINO, Reference 2.

Zig-Zag Tests: The results of the zig-zag maneuver are indicators of the ability of a ship's rudder(s) to control the vessel. Factors such as speed of the rudder control system, rudder effectiveness, as well as stability of the ship come into play. A standard procedure outlined as follows was utilized.

a. The ship is steadied on a straight course at a preselected speed for about one minute. Once a speed is established the power plant controls are not changed throughout the maneuver.

b. Rudder angle is deflected at maximum rate to left 20 degrees and held until the ship responds 20 degrees to the left of base course.

c. At that point the rudder is shifted 40 degrees, to right 20 degrees rudder and held until the ship responds in heading 20 degrees to the right of base course. This completes the overshoot test.

d. If a zig-zag test is to be completed, again the rudder is shifted 40 degrees, to left 20 degrees rudder. This cycle was

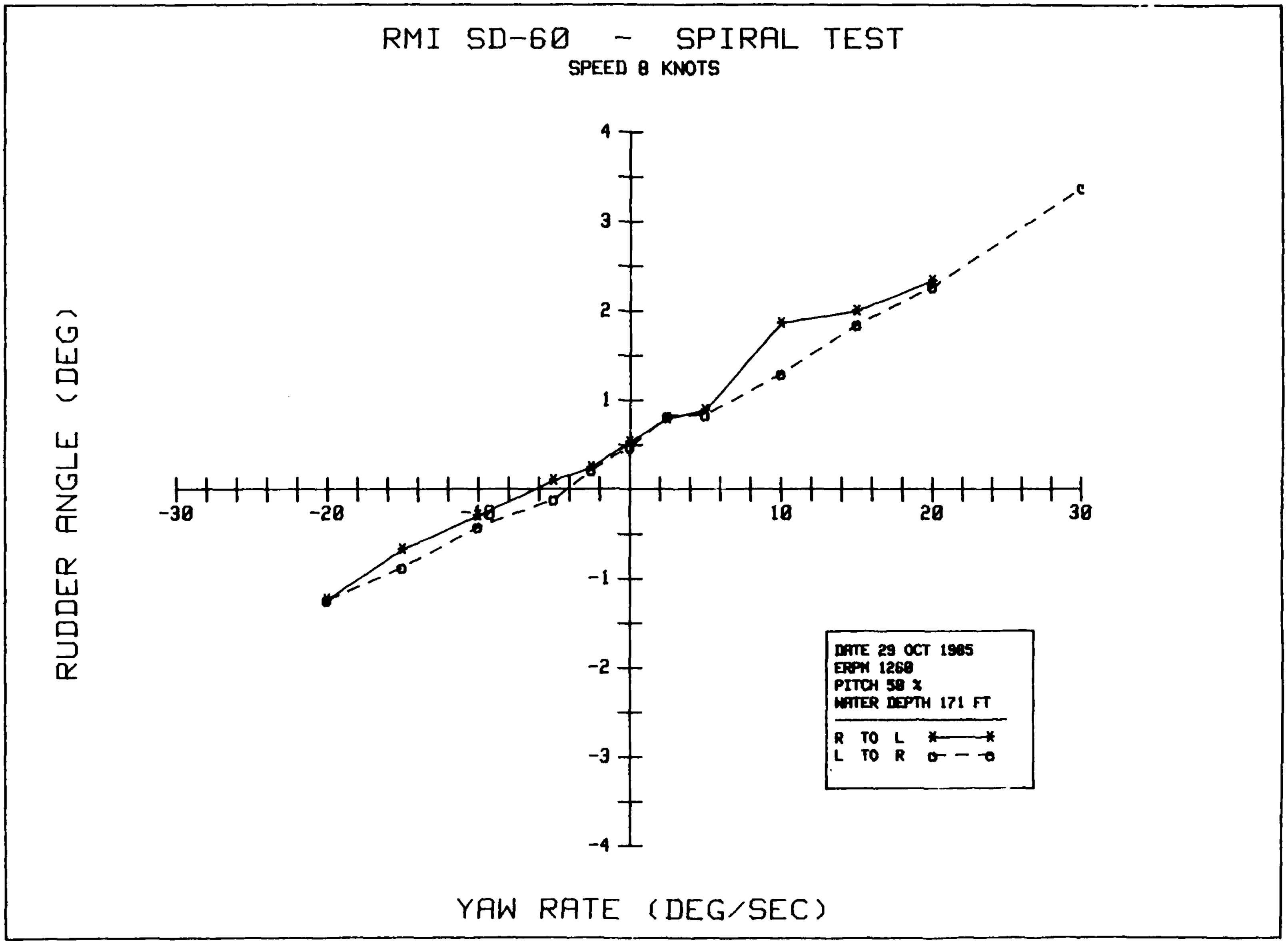

FIGURE 15. Spiral Plot - 8 Knots

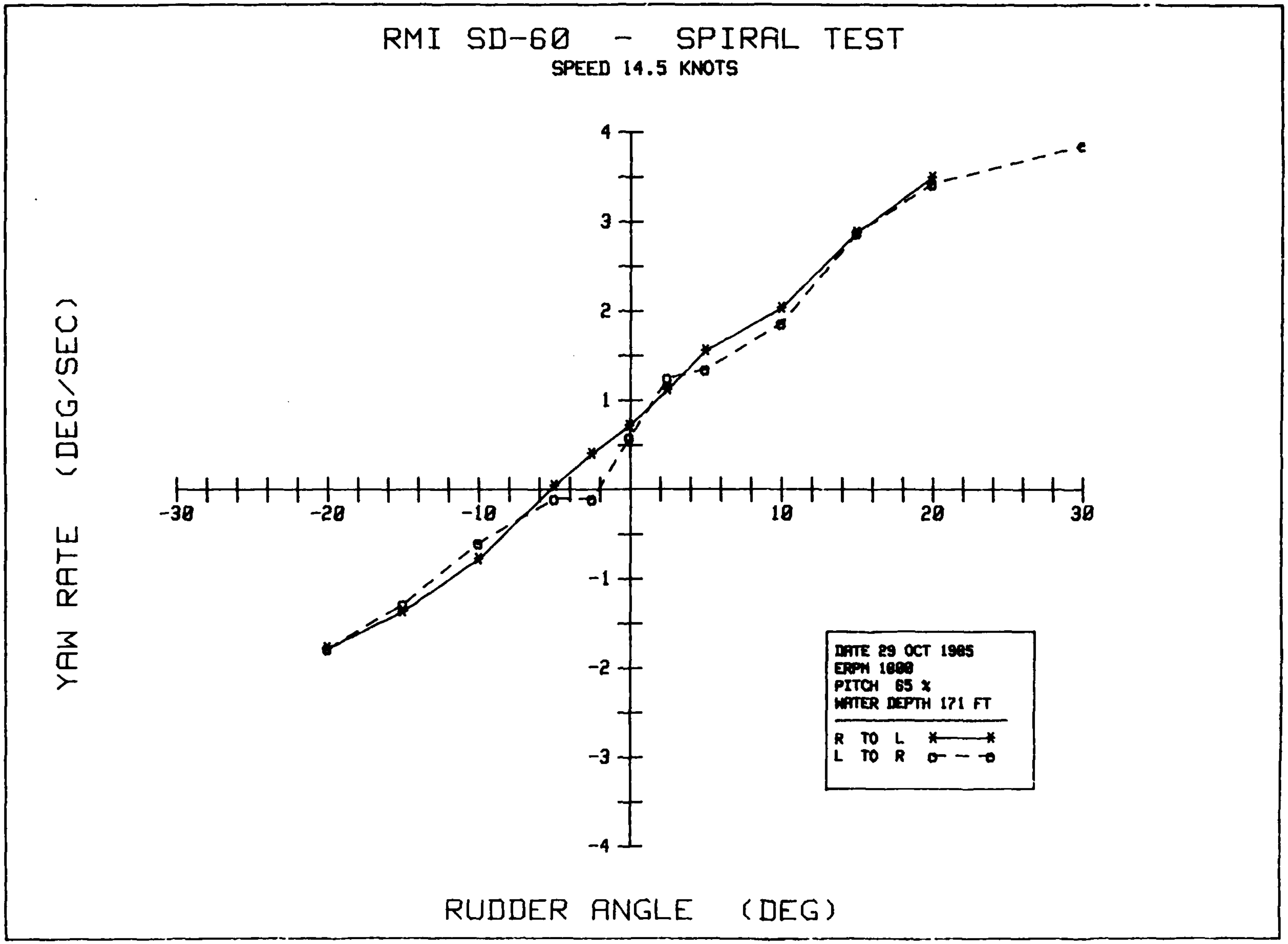

FIGURE 16. Spiral Plot - 14.5 Knots

repeated once more.

Zig-zag tests were conducted at 10 and 16 knots, as seen in Figure 16. Overshoot yaw angle is an indication of the amount of anticipation required of a helmsman while operating in restricted waters. The time for the ship to react to a 20 degree rudder change starting from rudder amidship on base course and ending with the ship's yaw angle changing 20 degrees, is an indicator of rudder effectiveness. Another indicator of rudder effectiveness is the "Period". This is the time it takes vessels to cycle through two course changes. In these tests it is the time starting with the first yaw angle reaching 20 degrees to port of base course cycling through 20 degrees to starboard of base course and ending when yaw angle again reaches 20 degrees to port. Table B-IV contains zig-zag results presented in Figure 17. The HALCYON responds quickly to rudder changes with little overshoot observed.

Tactical Data

A Raynav 750 Loran receiver was used in interface with a Hewlett-Packard 200 series computer to collect ship position data during turning cycle tests. Turning circles with two engines on line were initiated at 5.2, 9.8, and 18 knots using 10, 20, and 30° rudder angles. Very little outboard roll was experienced during high speed turns with RCS on. Tactical data is presented in Table IV. HALCYON tactical diameters at 18 knots are approximately four to five times smaller than those measured on the 82' and 95' WPBs, Reference 4. Tactical diameters at 8-10 knots, however, are very similar for all three vessels.

Towing and Bollard Pull

Towing Test: The HALCYON easily towed an 82' USCG patrol boat (WPB), the POINT BROWER, at speeds up to 12 knots in 4 foot swells. There is no towing bollard on the HALCYON, so a wire

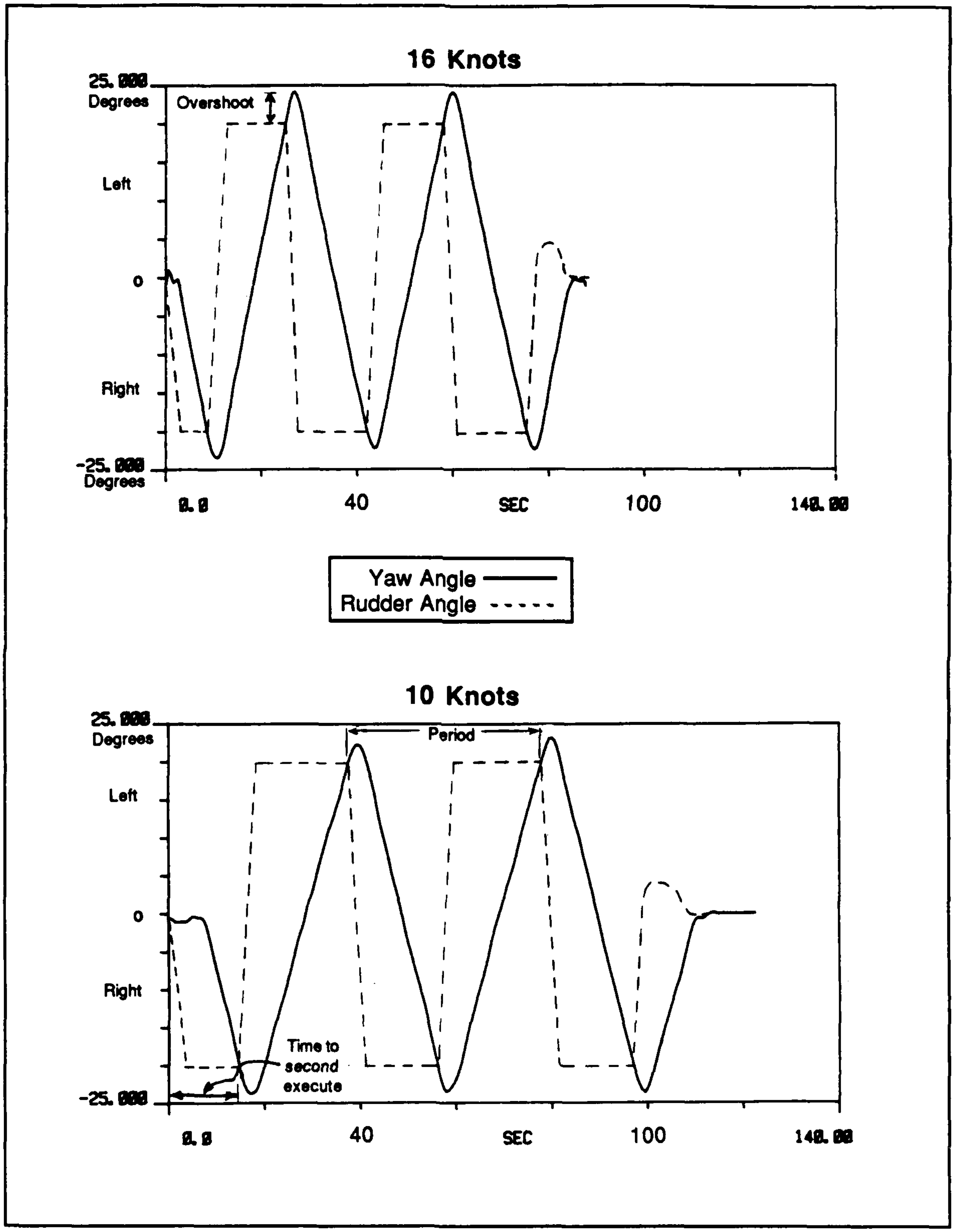

FIGURE 17. Zig-Zag Plots at 10 and 16 Knots

TABLE IV. HALCYON Tactical Data

TWO ENGINES — RCS On

DRAFT: FWD 7'6"
AFT 7'6"
DISPLACEMENT: 62 LT

SEAS: 3 FT. SWELLS
WIND SPEED: 3 KTS
WATER DEPTH: 250 FT.

Speed	Rudder Angle (Degrees)	Distances In Feet * Advance	Transfer	Tactical Diameter	Time To Turn (Seconds) 90°	180°	270°	360°	Maximum Outboard Roll Angle (Degrees)
SPEED: 5.2 KTS	10 Left	459	-393	1148	102	204	298	387	1
	10 Right	689	-426	1312	125	175	270	378	1
	20 Left	393	-114	557	52	100	156	200	1
	20 Right	574	-98	541	45	90	135	165	1
	30 Left	557	-49	278	40	76	111	144	1
	30 Right	196	-16	311	36	64	115	124	1
SPEED: 9.8 KTS	10 Left	1132	377	1706	68	144	220	292	1
	10 Right	918	328	1312	69	131	209	272	1
	20 Left	558	196	754	36	76	102	148	2
	20 Right	558	196	689	41	66	97	125	1.5
	30 Left	426	65	295	29	57	84	109	2.5
	30 Right	410	114	328	27	52	79	104	2.5
SPEED: 18 KTS	10 Left	1542	393	170	52	92	140	187	2
	10 Right	1017	147	190	48	96	140	192	1
	20 Left	689	131	105	32	64	96	128	2
	20 Right	689	131	105	32	60	84	111	3
	30 Left	639	131	131	40	56	87	111	2
	30 Right	524	213	78	24	48	68	88	4

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* DISTANCE ACCURACY ± 15 FT.

rope bridle was attached to the two corner stern cleats. The shaft of the POINT BROWER was allowed to freewheel. Maneuvering of the HALCYON was easily and expertly done in passing the wire rope to the 82′ WPB. The load cell was attached to the bow bollard of the POINT BROWER. Five discrete speeds were obtained from 3.7 to 12.1 knots with 3-4 foot swells off the starboard beam. Fuel consumption, horsepower, propeller pitch, engine rpm, vessel trim, and towline pull were measured. The data is presented in Table B-V.

A maximum 12.1 knot speed was obtained towing the 82 foot patrol boat, with 7,300 lbs. average tension. During the towing operations, the 60 foot HALCYON demonstrated superior roll stability compared to the 82′ WPB. The POINT BROWER was rolling 10-25 degrees while the HALCYON rolled 2-4 degrees. Turning with 15° rudders while towing was slow at 10.9 deg./min. This was attributed to a poor attachment point of the towline to the aft cleats which are directly above the rudders. Use of differential thrust would improve maneuvering capabilities while towing. Towing with one engine was not possible because it was too difficult to maintain course in that configuration.

Bollard Pull: A full power bollard pull was conducted on the HALCYON in 32 feet of water. The load cell was attached to the pier bollard. Bollard pull data at each power level tested is presented in Table B-VI. A maximum sustained pull of 19,700 lbs. was measured at 2,000 engine rpm and 50% pitch developing a total 1,084 shaft hp. The vessel trim was 8° up by the bow at that power level. The controllable pitch propellers enabled the vessel to obtain maximum thrust by adjusting the rpm and pitch independently. The pitch system can be operated in a pre-selected combined mode where pitch increases automatically with rpm increase or pitch can be controlled independently. This independent pitch control capability is excellent for optimizing power and reducing diesel engine carbon build-up during low speed towing operations.

Noise

Noise levels were measured on the bridge, mess deck, unfinished passenger space, and on the outside main deck aft between the two main engines. Sound covers were not installed on the main engines and generator sets. Main deck and passenger space measurements will be reduced substantially once the machinery is covered. A hand-held broad band B&K Type 213H meter was used. Readings were taken with both A and C weighting filters in the slow response mode. Data is presented in Table B-VII. Measurements with the A weighting filter above 85 dB exceed the 16 hour OSHA 28 CFR 1910 standard. All readings made within the compartments are below 85 dB and within the OSHA standard with the exception of open main deck aft measurements between the exposed main engines.

Stability

According to Reference 6, guidelines for determining the intact stability of the HALCYON were taken from Federal Regulations (171) with respect to vessels under 65F7, and DSS 079-1, Part II, which addresses stability and buoyancy of U.S. Navy surface ships.

The primary vertical watertight boundary of the HALCYON is a watertight platform deck at 8'6" above the baseline extending along the whole length of the strut and strut sponson intersection. The vessel is additionally divided into 16 watertight compartments in the cross structure and 16 below in each strut. The strut subdivisions would prevent progressive flooding in the event of shell-rip on the strut. Each cylindrical lower hull has 7 watertight compartments to limit the volume of flooding water in event of damage.

With beam wind of 60 knots, steady state angle of the heel will not exceed 12 degrees, according to Reference 6. Stability

test data (inclining experiment conducted by RMI for the Coast Guard) is presented as Appendix D. In the lightship condition, metacentric height (GM) was 4.69 feet. No adverse heeling was observed during retrieval of the 120 lb. wave buoy with three 180 lb. men at the beam rail of the HALCYON in seven foot seas.

Propulsion System and Hull Performance

Speed, power, and fuel consumption tests were conducted on the HALCYON with one and two engine configurations. The Caterpillar 3408 DI-TA marine diesels are rated 510 hp each at 2100 rpm. V-belt drives transfer power from the engines mounted topside at the main deck level to propeller shafts in the lower hulls as seen in Figure 5. The combined transmissions and belt system reduces shaft speeds by 3.01 to 1. The belt system can be tensioned from the main deck by adjusting the take up unit if there is slippage indicated by belt smoking. During the speed power trials some belt slippage was measured by comparing the shaft rpm measured on the lower shaft with our hp meter rpm pickup and the engine rpm corrected by the reduction ratio. This slippage amounted to 8% at 7 knots with 364 rpm and 10% at 19 knots at 420 rpm. There was no belt smoking observed and the accuracy of the engine rpm indicators are unknown. Permanent installation of a lower shaft rpm indicator would aid in monitoring belt slippage. If there is a catastrophic failure the belt will not damage the aluminum structure. The belts can be replaced in three hours with two people and the use of the deck crane and sound powered phones.

Horsepower was measured on the two lower pod shafts as seen in Figure 5. Torque strain gauge bridges were epoxied to the shafts. An Acurex FM telemetry system is used to power the gauge bridge and receive the torque signals. A processor box uses torque and rpm readings to compute shaft hp. Calibration is accomplished using a shunt resistor to simulate a specified torque level. The shunt resistor value is calculated from shaft

dimensions and shear modulus (G) data for a specified torque level.

Fuel consumption was measured on both main engines using a Halda marine fuel flow management system. The system is very accurate because the return fuel flow to the fuel tank is diverted back to the flow sensor so that only make up fuel to the closed circulation loop is measured. The meter on the port side failed to operate properly in the 5 to 15 knot speed ranges while the starboard system performed well at all speeds. The system was sensitive enough to measure one to two gallons per hour (GPH) differences while surfing down and climbing up four foot swells in following seas. Estimates of port engine fuel consumption during sensor failures were made by matching flow data on the starboard engine at the same rpm and pitch settings. Speed, power, fuel consumption, range, endurancy, and efficiency data for two and single engine operations are presented in Tables B-VIII and B-IX. Fuel consumption tests with two engines show the optimum fuel efficiency speed is 12.0 knots with 1.8 gal./nm fuel efficiency and 1300 nm range. Single engine maximum speed is 13.2 knots and most efficient at 8.2 knots with 1.2 gal./nm efficiency and a range of 2,000 nm. Power plant and hull performance curves are plotted in Figures 18 through 23. Assumptions made are that 98% fuel would be used and that one GPH fuel was consumed by the operation of one 25 kw generator. The endurance plot does not assume current limitations on food storage capabilities, which would most likely limit deployment with a crew of six to approximately five days underway.

Comparison of HALCYON fuel consumption to both the 95′ and 82′ Coast Guard WPBs is presented in Figure 24. The HALCYON is more fuel efficient than the 82 foot WPB at speeds above 14 knots, and better than the 95 foot WPB above 17 knot operations. The HALCYON has approximately the same range and endurance as the 95′ WPB, and about twice that of an 82′ WPB, at 18 knot operations. Seakeeping tests in seven to eight foot seas

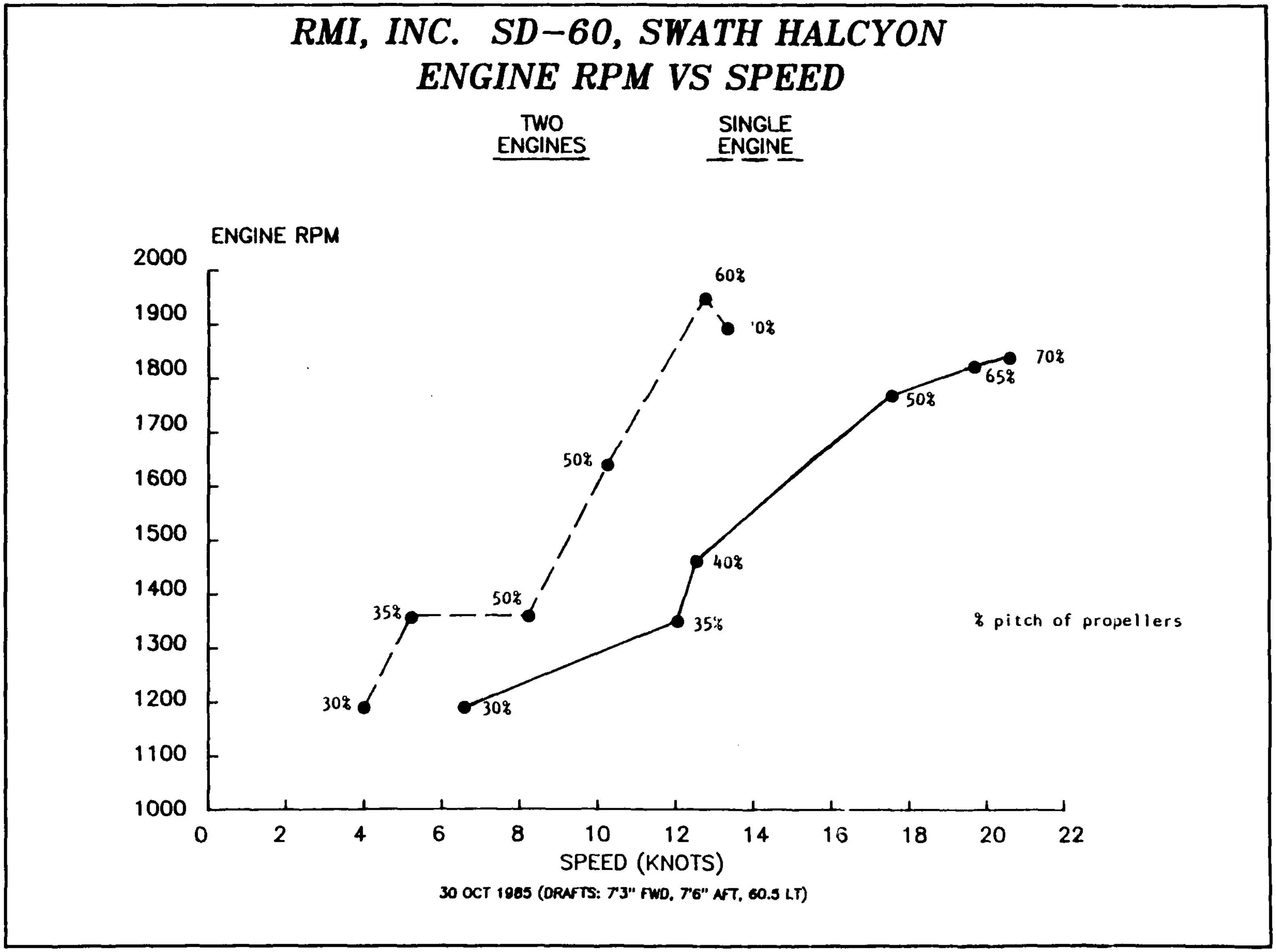

FIGURE 18. Engine RPM vs Speed

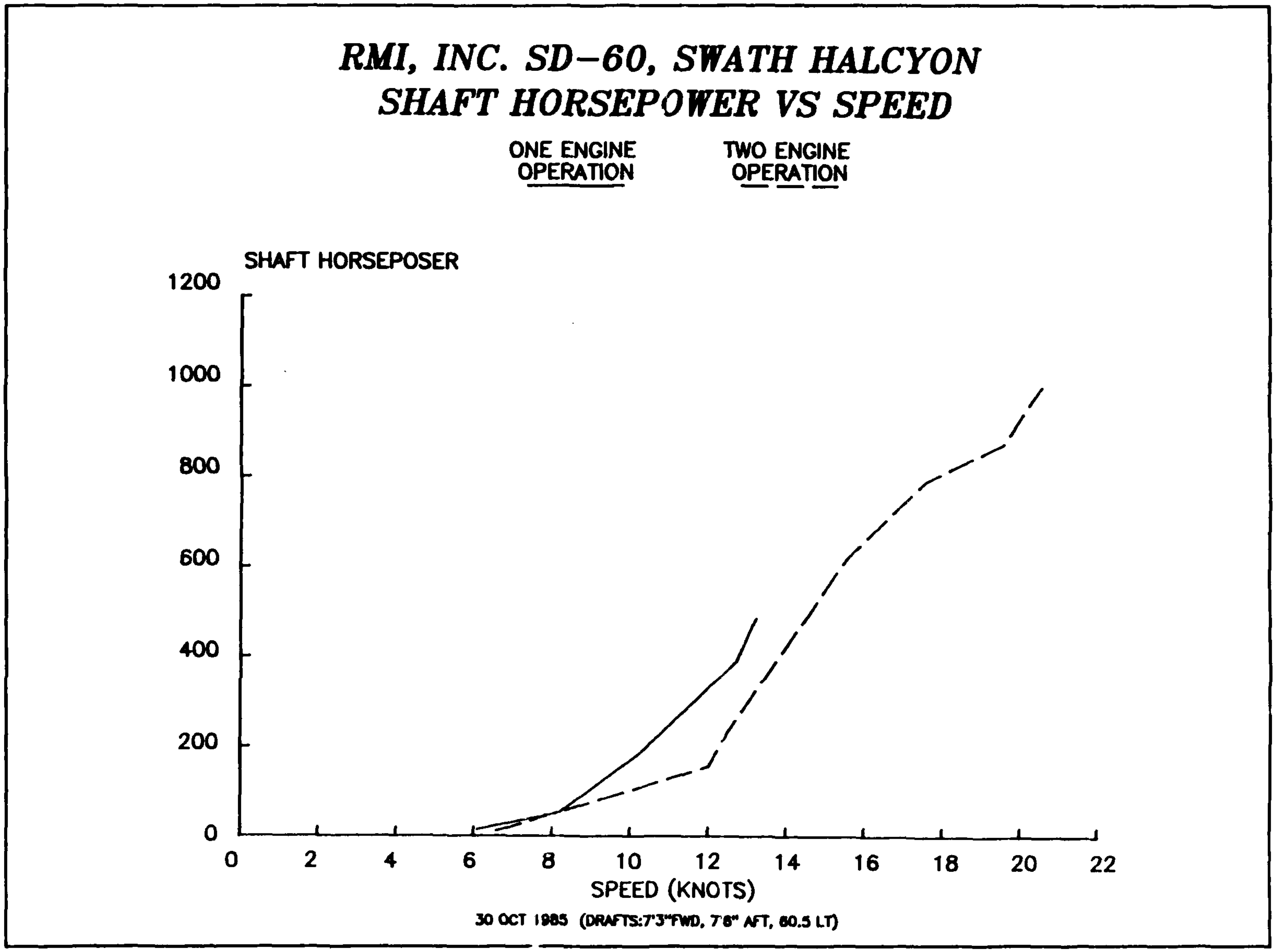

FIGURE 1). Shaft Horsepower vs Speed

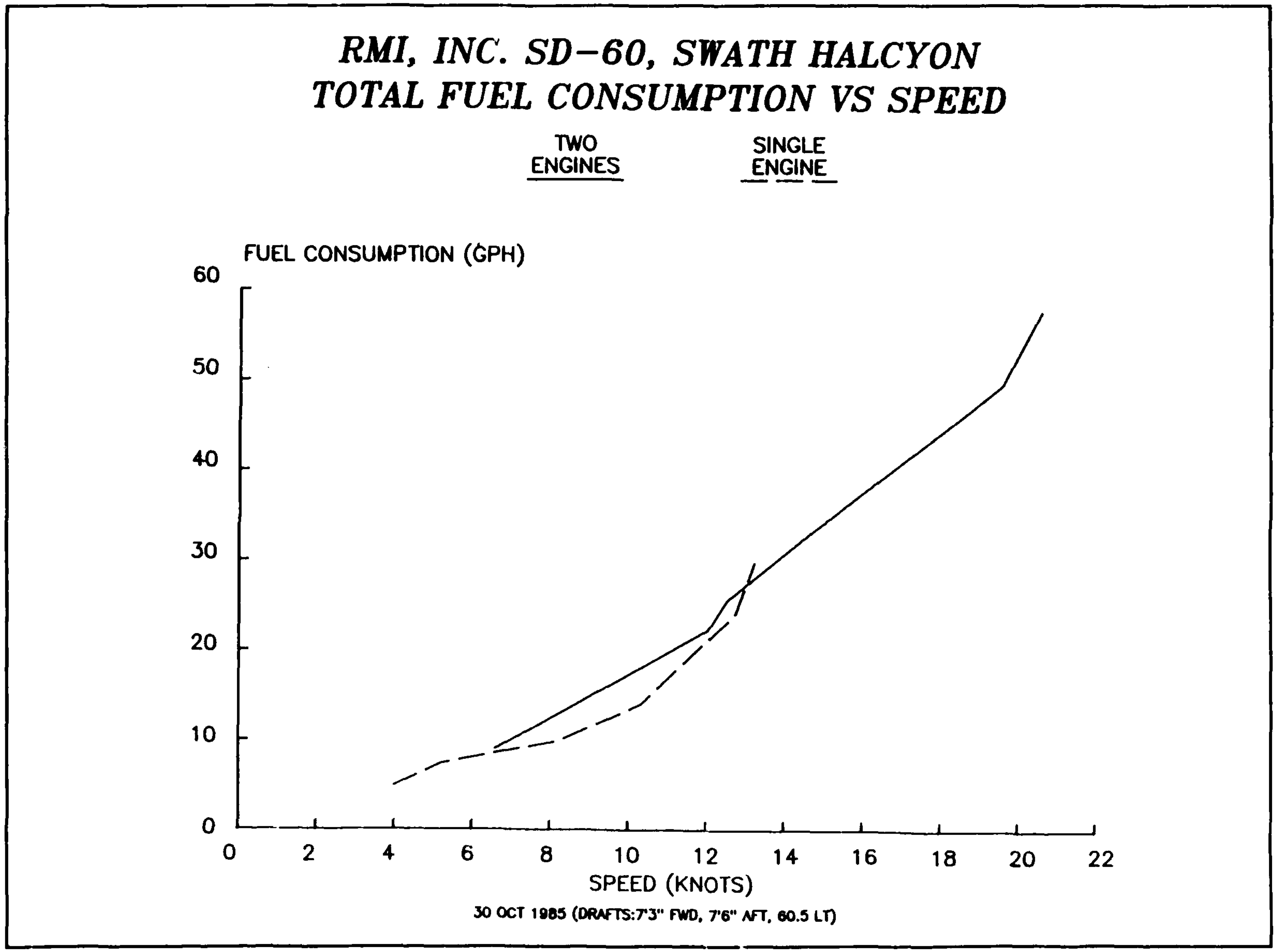

FIGURE 20. Total Fuel Consumption vs Speed

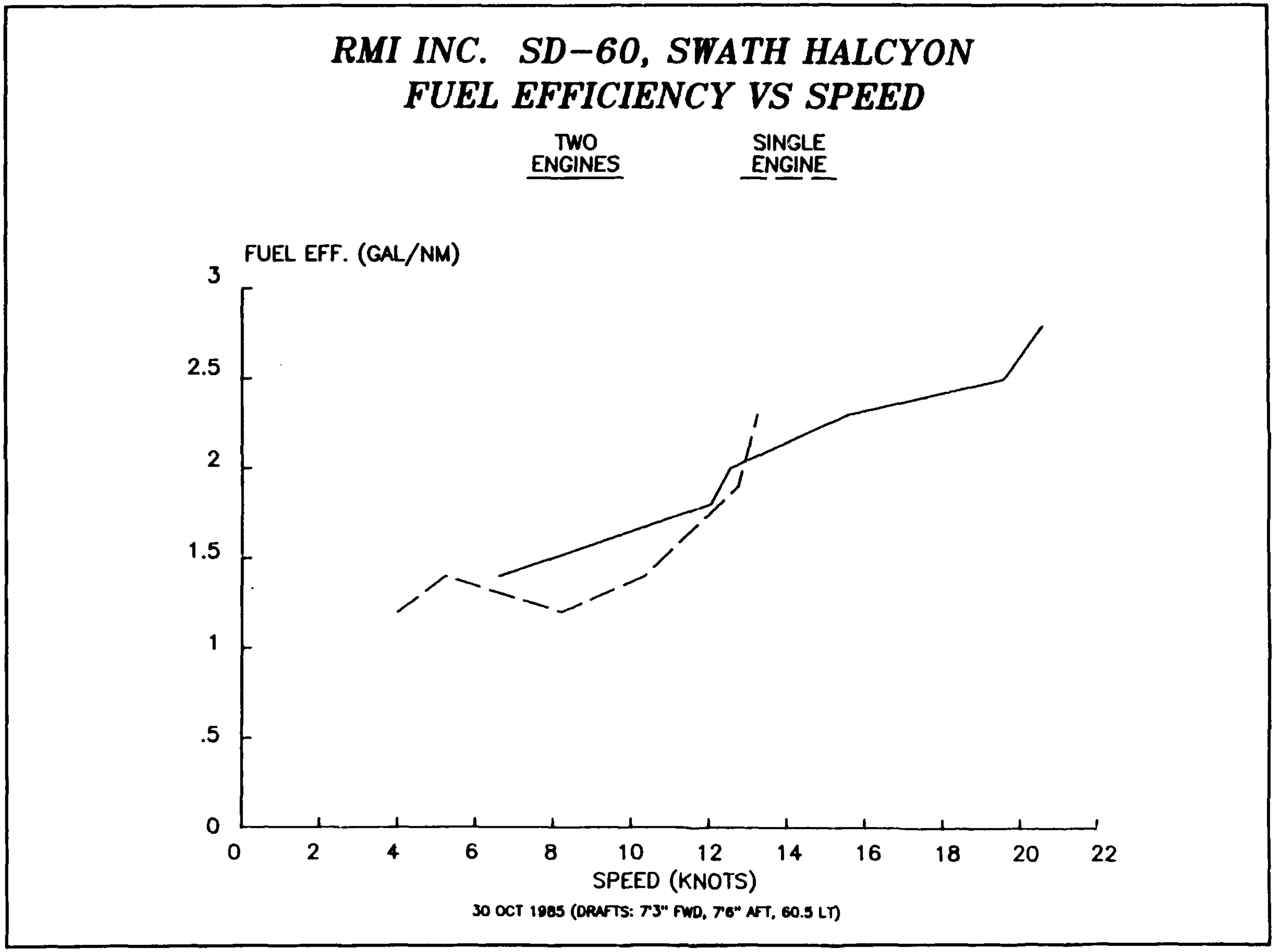

FIGURE 21. Fuel Efficiency vs Speed

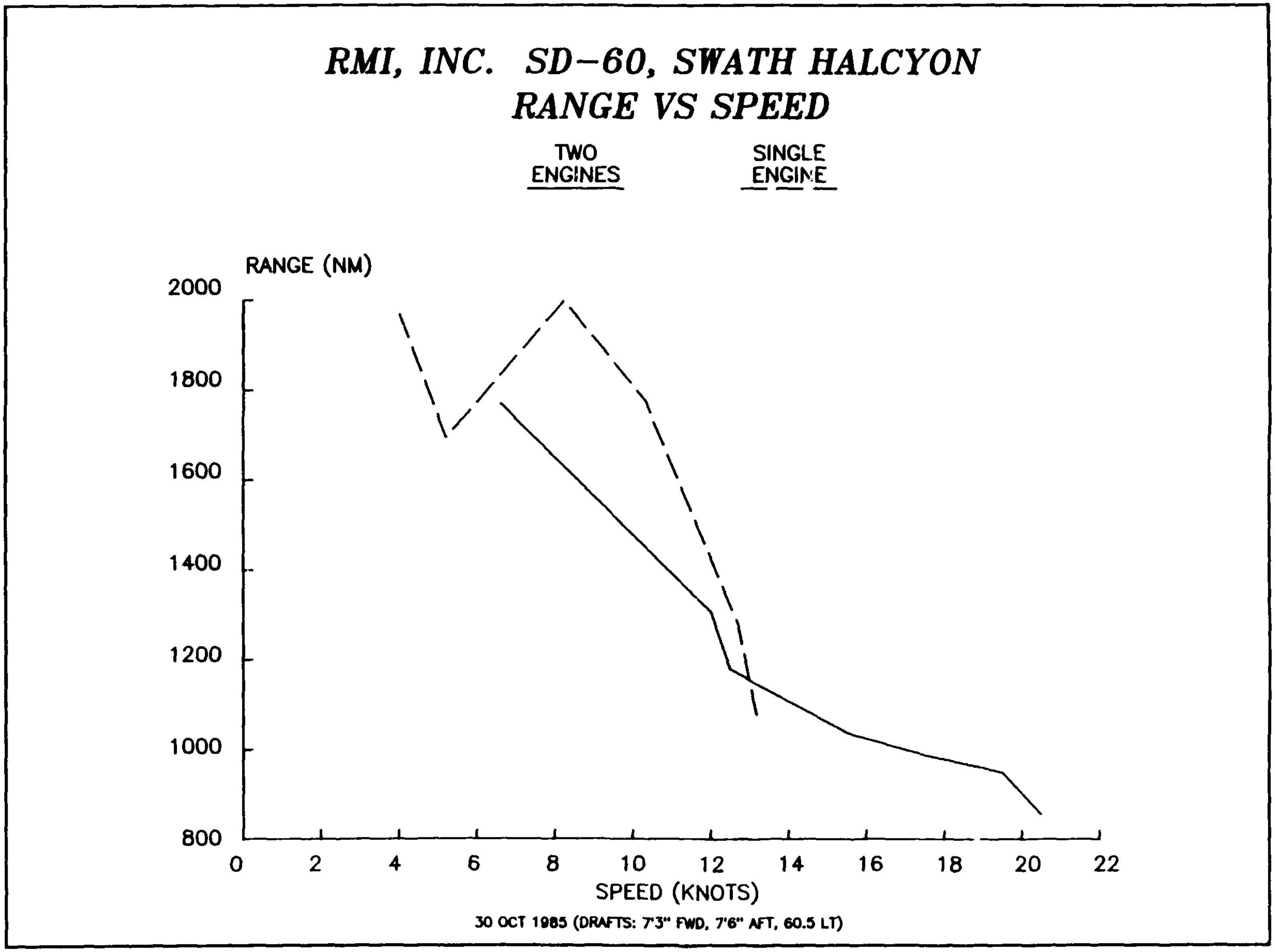

FIGURE 22. Range vs Speed

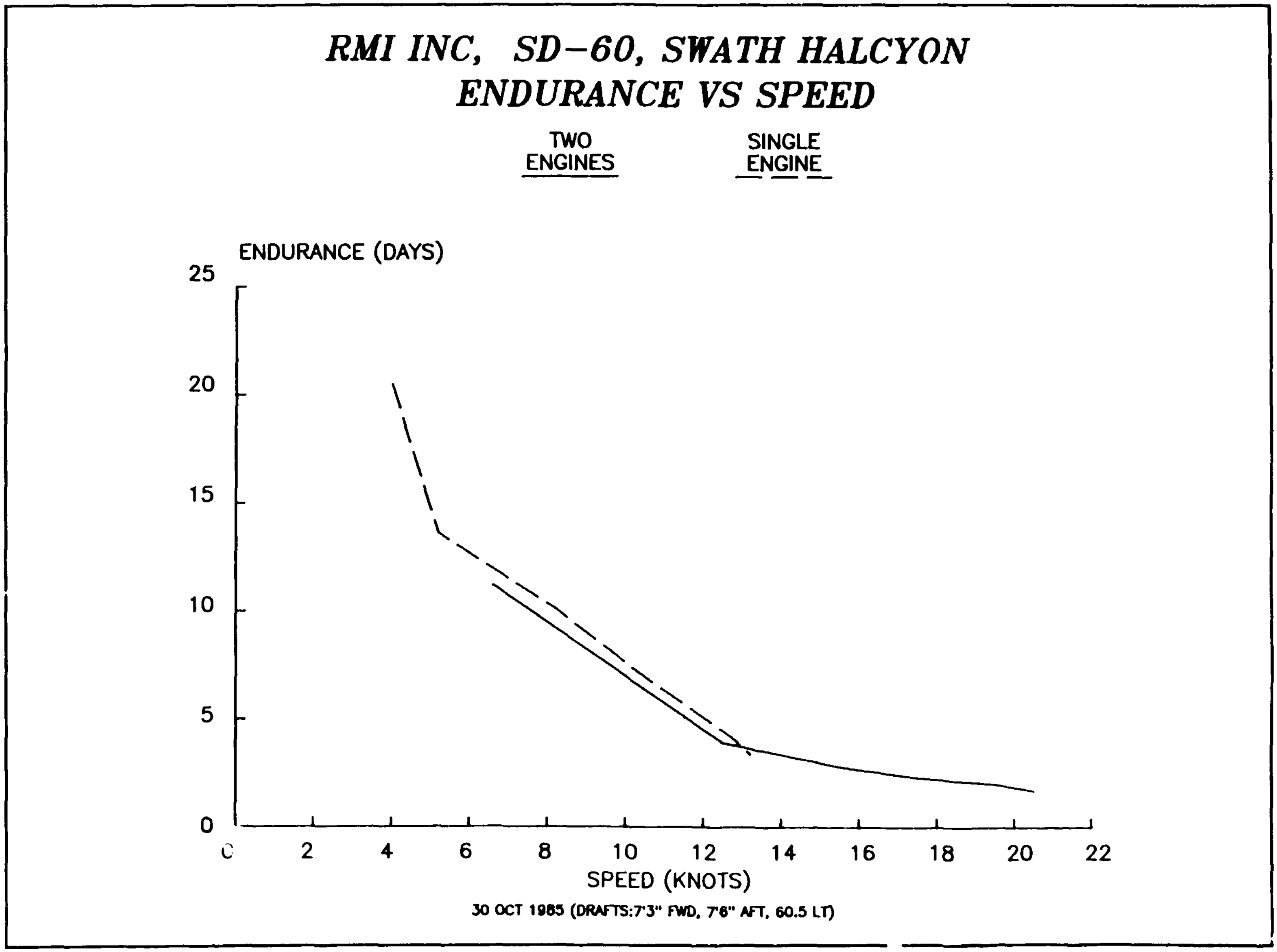

FIGURE 23. Endurance vs Speed

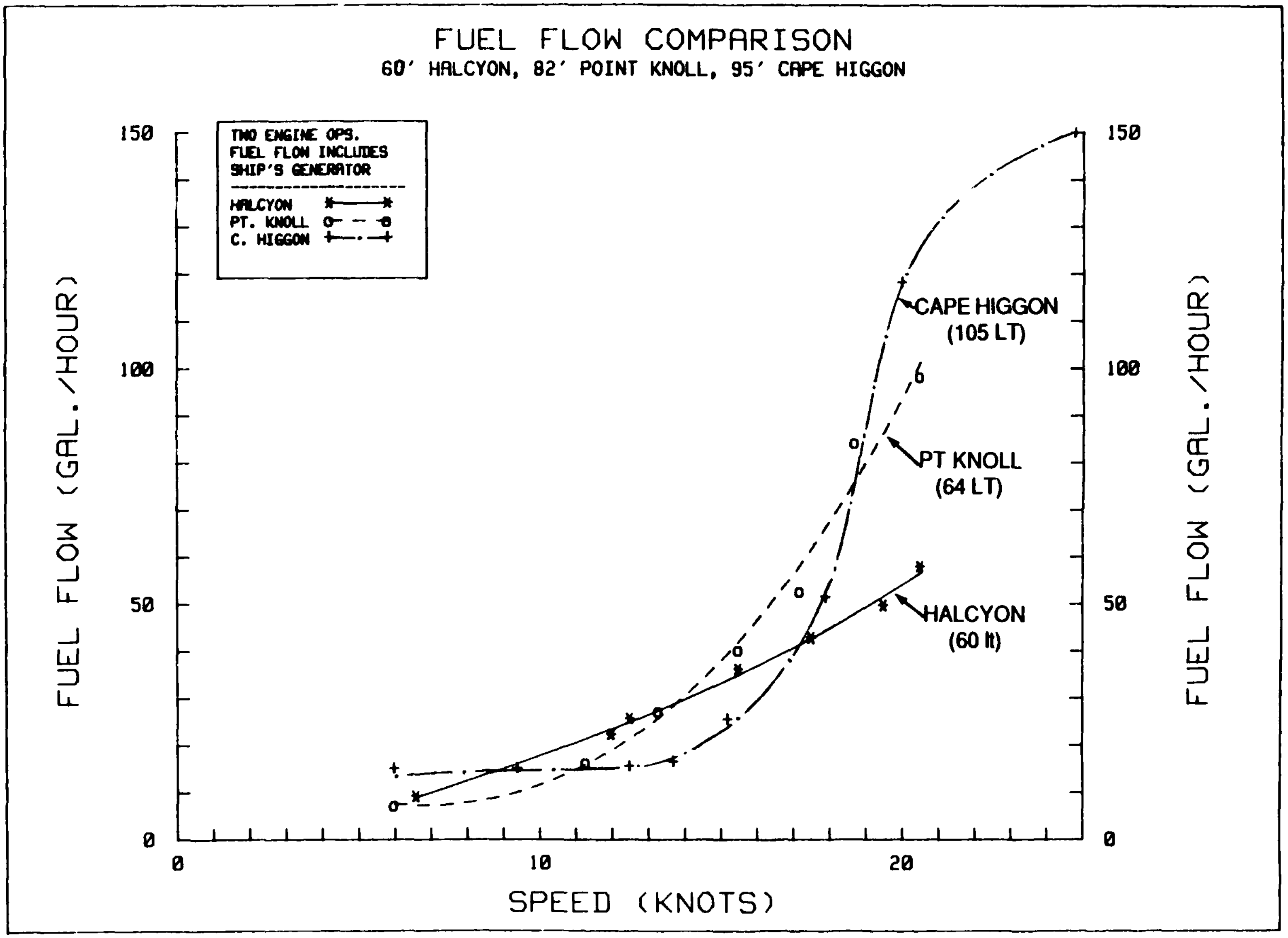

FIGURE 24. Fuel Consumption Comparison of HALCYON with 82' and 95' WPB s

demonstrated that the HALCYON can maintain 17.5 knots cruise speed in a 7-8 foot seaway.

CONCLUSIONS

The HALCYON SWATH ship has demonstrated that a small SWATH (60 foot, 60 long tons) is an outstanding seakeeping platform in 7-8 ft seas at 17.5 knots and while dead in the water. It can maintain speed in a seaway with ship motions significantly lower than all equivalent sized and larger U.S. Coast Guard Patrol Boats including 82 foot Point Class, 95 foot Cape Class, 110 foot Island Class, and 110 foot SES Sea Bird Class vessels (References 4, 5, and 8). A detailed seakeeping comparison between the HALCYON and the USCGC PT KNOLL, an 82 foot semi-displacement monohull, was conducted using RAOs. Results show the SWATH HALCYON has dramatically lower roll, pitch and heave motions in 5 ft seas when compared to the equivalent sized monohull.

The liability of this ship as with any SWATH is that it is more weight sensitive and has a larger draft than an equivalent size displacement vessel. Care must be taken to prevent over loading a SWATH as required for any weight sensitive craft such as planing vessels, surface effect ships and hydrofoils.

The HALCYON has approximately the same range and endurance as a 95' WPB and about twice that of an 82' WPB at 18 knot operations. The fuel consumption of the HALCYON is competitive with the 95' and 82' WPBs at low speeds and superior to them above 18 knots. The HALCYON demonstrated excellent maneuverability in spiral, zig-zag and turning diameter tests conducted. An 82 foot 62 long ton WPB was easily towed at 12 knots in 4 foot swells.

Reduced ship motions of the SWATH concept have great potential benefits in many operational situations. The outstanding roll stability demonstrated in rough seas while dead

in the water is similar to that of our SESs which has proven to be a valuable attribute for preserving crew effectiveness during boarding operations and loitering tactics commonly used in drug interdiction missions. Due to reduced vertical accelerations at all speeds, the crew on a SWATH will experience less seasickness than a crew on a monohull and can operate with prolonged mental alertness and physical stamina resulting in improved mission effectiveness, (Reference 9). Improved stability provides substantial potential for greater weapon system and sensor accuracy. The platform offers flexibility of arrangements due to large deck area and enclosed volume. SWATH ships 300 LT and larger can deploy and service helicopters in higher sea states compared to monohull displacement vessels of similar displacements (Reference 10). Previous SWATH evaluations listed above and this HALCYON technical evaluation demonstrate that the SWATH concept is an outstanding candidate for replacement of aging Coast Guard WPBs in rough water operating areas.

RECOMMENDATIONS

The short term technical evaluation of the HALCYON and buoy tender evaluation of the SSP KAIMALINO have demonstrated the superior seakeeping and speed in the seaway performance capabilities of the SWATH concept. A long term (1 year) operational evaluation is recommended in order to quantify and demonstrate the SWATH concept capabilities to accomplish Coast Guard missions in rough water operational areas. A significant number of SWATH platforms now exist such that a lease is feasible to obtain a suitable WPB or WMEC type platform. Another option is to design, build and evaluate a SWATH WPB demonstration craft. SWATH operational and reliability capabilities can only be assessed through a long-term evaluation. Concerns about draft, weight sensitivity and drive train maintainability can be addressed. New operational tactics can be explored to possibly improve mission performance given the greater seakeeping capabilities of the SWATH design.

Operational evaluations of hydrofoils, surface effect ships and air cushion vehicles have been accomplished in the past and proven to be beneficial in evaluating the applicability of new technologies to improve Coast Guard mission performance. This evaluation will quantify the operational performance capabilities of the SWATH concept to Coast Guard Law Enforcement, Search and Rescue, and Military Defense operations missions to facilitate informed vessel acquisition decisions.

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APPENDIX A

DESCRIPTION OF INSTRUMENTATION

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EQUIPMENT	DESCRIPTION
<u>SHIP MOTION PACKAGES</u> HUMPHREY, Inc.	This unit consists of a vertical gyro, a vertically stabilized three-axis accelerometer assembly, a directional gyroscope, a three-axis rate gyro assembly and all necessary power supplies and power switching relays. Nine outputs are available at $\pm$ 1 or $\pm$ 5 volts full scale with or without a 10 Hz low pass filter. Full-scale outputs can be varied as the table below indicates.
Pitch Angles	$\pm$ 45°, 25° or 10°
Roll Angles	$\pm$ 45°, 25° or 10°
Yaw Angles	$\pm$ 175°
Pitch and Roll Rate	60, 30 or 10 deg/sec
Yaw Rate	30, 10 or 5 deg/sec
Surge & Sway Acceleration	$\pm$ 1.0 or 0.5 G's
Heave Acceleration	$\pm$ 2.0 or 0.5 G's
<u>STORE 14D ANALOG TAPE RECORDER</u> Lockheed Electronics Company	This analog tape recorder can record up to 14 channels including one voice channel which records on channel 14 and overruns data if recorded on that channel. It has seven variable speeds from 15/16 IPS up to 60 IPS. It can attenuate signals from 0.1 to 20 volts peak to peak normalizing the recorded signal to 1 volt peak to peak output.
<u>ENDECO 956 WAVE TRACK BUOY</u>	This orbital following wave buoy measures wave height and direction. It transmits three digital signals; wave height, buoy tilt (East-West), and buoy tilt (North-South) to a remote receiver usually deployed with the test vessel. The digital signals are recorded and analyzed using an Otrona 8:16 microcomputer. The data can be analyzed using either a "LONGUEST-HIGGONS" or "DIGITAL BAND PASS FILTERING" method. The output is Significant Wave Height (H 1/3) and significant period as well as a plot of wave energy vs. frequency and direction. This allows for a determination of the major swell direction and quantification of the extent of a undirectional or confused sea state. Directional accuracy is $\pm$ 10°. It can be moored with an accumulator mooring system for long-term monitoring situations.

HUMAN-RESPONSE VIBRATION METER Type 2512 Bruel & Kjaer (B&K) Marion, MA

Measures vibration from a tri-axial accelerometer for the evaluation of vibration on the human body in agreement with current ISO standards for Hand-Arm and Whole-Body (including motion sickness) measurement. The complex relationship between level, frequency and time is automatically taken into account in the computation of equivalent continuous vibration level and exposure dose. Outputs are printed on thermal paper with the use of a Alphanumeric Printer type 2312. Outputs are automatically printed at preselected intervals in the form of: Current Time, Elapsed Time, Peak Acceleration (dB), Equivalent Exposure (dB) and Percent of a particular ISO standard selected which has been reached at that elapsed time.

TRIAXIAL SEAT ACCELEROMETER Type 4322 (used with B&K Meter Type 2512)

This accelerometer is especially designed for detecting vibration motion in connection with the measurement of whole-body vibration and can be put under the buttocks of a seated person.

Frequency Range:	0.1 Hz to 2 kHz ($\pm$ 5%)
Charge Sensitivity:	1 pC/ms^{-2} $\pm$ 2% 10 pC/g
Piezoelectric Material:	PZ27
	Delta Shear Configuration

ACCELEROMETER CHARGE AMPLIFIERS Type 2651 Bruel & Kjaer Marion, MA

Various ship vibration measurements are made using Bruel & Kjaer (B&K) accelerometers and charge amplifiers. The output of the charge amplifiers are recorded on magnetic tape. Two types of B&K accelerometers are used; they are the 4368 and the 4384. The charge amplifiers used were the Model 2651. The Model 2651 charge amplifier needs a power supply (and is packaged in a pack of four amplifiers with the power supply); transducer sensitivity conditioning settings of 0.1, 1, and 10 mV/pC.

Frequency Range:
Acceleration.003 to 200kHz

General B&K accelerometer information follows:

Model	Charge Sensitivity	Frequency Range	Temperature Range (deg. C)
4368	4.8 pC/ms^{-2}	.2 to 5000	-74 to 250
4384		.2 to 9200	-74 to 250

HALDA FUEL FLOW METERS (2)
PFS ENTERPRISES, INC.
5225 Old Orchard Rd. #48
Skokie, Il 60077

HALDA MARINE 3800: This fuel economizer system measures make-up fuel flow to a closed circulation loop on the engine fuel intake and fuel return lines. The accuracy of the displacement piston meter is rated at ± 1%. A display panel provides a digital display of fuel consumption in GPH, the difference between current consumption and a stored reference level, total consumption for a trip, and engine hours. An RPM sensor can be interfaced to the meter as well.

HORSEPOWER METER 1202A (2)
ACUREX AUTODATA,
Mountain View, CA

The 1202A measurement system measures shaft torque and rpm and calculates horsepower from that information (HP = Torque x rpm x Constant). The shaft has strain gauges epoxied for torque measurement. A transmitter collar and antenna are bolted to the shaft in order to power and transmit FM signals from the strain gauge bridge. Three simultaneous analog outputs are provided at the readout box (Torque, HP and rpm). Calibration using a shunt resistor is usually conducted because a known torque load is difficult to apply to a vessel in the water. This method simulates a torque load by shunting a gauge with a known value of resistance.

SPECIFICATIONS

Accuracy:	Torque	± 1% of full scale
	rpm	± 0.25% of full scale
	Horsepower	± 1.5% of full scale

SOUND LEVEL METER TYPE 213H
Bruel and Kjaer
Marlborough, MA

This hand-held sound level meter measures levels from 50 to 130 dB with A or C weighting filters. It can be used with fast or slow response. Calibration is done by using a Sound Level Calibration unit Type 4230. The sound pressure level of the calibrator is 93.6 dB.

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APPENDIX B

TABULAR PERFORMANCE DATA

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TABLE B-I

SWATH HALCYON Seakeeping
1 November 1985
7.4 ft Significant Seas
Speed: 17.5 Knots

ALL MOTION VALUES ARE SINGLE AMPLITUDE

Relative Sea Direction	Averaging Type	Roll Angle Degree	Pitch Angle Degree	Accelerations are in Gravitational Units (G's)					Roll Rate Deg/Sec	Pitch Rate Deg/Sec
				Heave at CG	Surge at CG	Sway at CG	Heave at Mess Deck	Heave at Bridge		
HEAD (15 MIN.)	1/10	1.246	1.544	.164	.074	.053	.205	.202	1.739	1.261
	1/3	.984	1.100	.125	.055	.043	.143	.145	1.308	.844
	RMS	.711	.758	.096	.040	.031	.110	.111	.935	.641
	MEAN	.649	.648	.090	.036	.029	.099	.101	.832	.535
	HIGHEST PEAK	1.557	1.739	.249	.140	.063	.449	.404	3.084	4.457
BOW QTR (15 MIN.)	1/10	1.597	.790	.162	.085	.062	.204	.199	1.571	1.431
	1/3	1.186	.606	.125	.062	.049	.145	.147	1.173	.860
	RMS	.840	.457	.095	.044	.036	.108	.109	.830	.663
	MEAN	.730	.427	.089	.039	.033	.098	.100	.736	.528
	HIGHEST PEAK	3.096	1.270	.217	.151	.094	.341	.331	2.254	3.617
BEAM (20 MIN.)	1/10	1.613	1.026	.124	.036	.081	.145	.146	2.289	.594
	1/3	1.331	.737	.100	.029	.063	.116	.114	1.850	.468
	RMS	.995	.544	.079	.022	.046	.091	.089	1.306	.367
	MEAN	.925	.500	.075	.021	.041	.087	.085	1.165	.350
	HIGHEST PEAK	2.376	1.189	.186	.051	.117	.203	.178	3.399	1.034
STERN QTR (20 MIN.)	1/10	1.815	1.705	.040	.055	.038	.144	.127	1.703	.559
	1/3	1.480	1.457	.031	.044	.031	.113	.106	1.324	.471
	RMS	1.080	.956	.022	.033	.023	.084	.081	.914	.363
	MEAN	.987	.82[illegible]	.020	.030	.021	.079	.077	.798	.347
	HIGHEST PEAK	2.360	1.999	.058	.068	.055	.170	.145	2.784	.867
FOLLOWING (20 MIN.)	1/10	1.597	1.962	.038	.052	.037	.144	.132	1.328	.675
	1/3	1.303	1.543	.030	.042	.030	.107	.107	1.057	.563
	RMS	.964	1.080	.023	.031	.022	.083	.080	.756	.424
	MEAN	.894	.961	.021	.030	.021	.079	.076	.686	.400
	HIGHEST PEAK	1.794	2.349	.065	.062	.050	.162	.177	1.681	.826

NOTE: Ride Control System Activated

TABLE B-II

SWATH HALCYON Seakeeping
1 November 1985
7.2 ft Significant Seas
Speed: 0 Knots Dead in the Water

ALL MOTION VALUES ARE SINGLE AMPLITUDE

Relative Sea Direction	Averaging Type	Roll Angle Degree	Pitch Angle Degree	Heave at CG	Surge at CG	Sway at CG	Heave at Mess Deck	Heave at Bridge	Roll Rate Deg/Sec	Pitch Rate Deg/Sec
				Accelerations are in Gravitational Units (G's)						
HEAD (10 MIN.)	1/10	3.201	4.751	.105	.073	.046	.162	.178	2.662	4.233
	1/3	2.636	3.804	.081	.055	.037	.129	.137	2.173	3.476
	RMS	1.859	2.678	.058	.039	.027	.099	.106	1.540	2.448
	MEAN	1.660	2.363	.053	.036	.025	.095	.100	1.392	2.186
	HIGHEST PEAK	4.193	6.305	.134	.098	.057	.205	.255	3.292	5.705
BEAM (20 MIN.)	1/10	7.448	2.98	.111	.041	.074	.135	.141	6.731	2.716
	1/3	6.063	2.256	.094	.033	.059	.109	.116	5.438	2.092
	RMS	4.480	1.597	.076	.024	.043	.086	.090	3.942	1.483
	MEAN	4.096	1.413	.074	.023	.040	.083	.086	3.533	1.322
	HIGHEST PEAK	9.105	4.059	.129	.050	.090	.198	.205	8.977	3.884
			SPEED 0-3 KTS - 7.2 FT SIGNIFICANT SEAS							
VARIOUS HEADINGS DURING BUOY DEPLOYMENT	1/10	6.450	5.150	.139	.069	.082	.205	.174	5.217	4.481
	1/3	4.973	3.870	.113	.050	.066	.143	.140	3.935	3.496
	RMS	3.465	2.688	.087	.036	.046	.110	.106	2.747	2.463
	MEAN	3.025	2.334	.084	.031	.041	.099	.099	2.417	2.194
	HIGHEST PEAK	8.907	7.381	.173	.117	.099	.286	.267	6.319	5.714

NOTE: Ride Control System Off
Engines used to maintain desired heading orientation to waves.

TABLE B-III. Spiral Data

SPEED 8 KTS
TWO ENGINES

ERPM 1260 — WATER DEPTH 171 FT.
PITCH 50% — RCS ON

Rudder Angle (Deg)	Yaw Rate (Deg/Sec)
20 Right	2.33
15 R	2.00
10 R	1.86
5 R	.88
2.5 R	.79
0	.53
2.5 Left	.24
5 L	.09
10 L	-.30
15 L	-.68
20 L	-1.24
15 L	-.87
10 L	-.41
5 L	-.11
2.5 L	.22
0	.48
2.5 Right	.82
5 R	.84
10 R	1.30
15 R	1.85
20 R	2.27
30 R	3.39

SPEED 14.5 KTS
TWO ENGINES

ERPM 1800 — WATER DEPTH 171 FT.
PITCH 65% — RCS ON

Rudder Angle (Deg)	Yaw Rate (Deg/Sec)
20 Right	3.49
15 R	2.87
10 R	2.03
5 R	1.55
2.5 R	1.11
0	.71
2.5 Left	.40
5 L	.04
10 L	-.78
15 L	-1.37
20 L	-1.78
15 L	-1.28
10 L	-.59
5 L	-.10
2.5 L	-.10
0	.59
2.5 Right	1.25
5 R	1.35
10 R	1.86
15 R	2.88
20 R	3.43
30 R	3.85

MSB-Coe-Halc-Tab.

TABLE B-IV. Zig Zag Data

SWATH HALCYON — Two Engines

	Speed 10 kts	Speed 16 kts
Time to second execute (seconds)	14	8.5
Period (seconds)	41	33
Average overshoot (degrees)	3.3	3.7

MSB-Coe-Halc-Tab.

TABLE B-V. Towing at Sea with Two Engines

HALCYON Towing USCGC POINT BROWER (82' WPB)
31 Oct 1985

HALCYON DRAFT: FWD 7'6" AFT 7'10"
DISPLACEMENT: 63 LT

WATER DEPTH: 200 FT
SEAS: 4 FT BEAM SWELLS
WIND: 5 KTS

POINT BROWER (freewheeling propellers)
DRAFT: 3'8" AFT 5'10"
DISPLACEMENT 64 LT

Speed (Kts)	Propeller Pitch % (Both Props)	Nominal Engine RPM	Trim Up By Bow Degrees	PORT MAIN ENGINE				STBD MAIN ENGINE				Towline Pull (lbs) ( ) average towline pull
				SRPM	Torquo (Ft Lbs)	HP	Fuel Con. (Gal/Hr)	SRPM	Torque (Ft Lbs)	HP	Fuel Con. (Gal/Hr)	
3.7	30	1330	1	389	--	58*	5.0	362	836	58	5.0	600-2000 (1000)
6.2	50	1630	1.5	479	1602	146	11.7	477	1699	154	10.0	1600-4200 (2600)
9.0	55	1835	2.5	541	--	276*	14.6*	539	2688	276	14.6	2500-6700 (4200)
10.5	60	2000	4.0	588	4929	387*	20.9*	584	3477	387	20.9	4500-8800 (5800)
12.1	62	2060	5.0	593	--	495	26.2	594	4375	495	27.2	5000-10,000 (7300)

MSB-Coe-Halc-Cht.

* Port torque signal and port fuel flow meter were working intermittently. On selected runs, HP and fuel consumption were estimated from starboard engine performance at the same rpm and pitch settings.

TABLE B-VI. Bollard Pull - HALCYON

2 NOVEMBER 1985

END OF RMI PIER — DRAFT: 8'0" FWD 7'5" AFT
WATER DEPTH 35' — DISPLACEMEMT: 64 LT

Propeller Pitch % (Both Props)	Nominal Engine RPM	Trim Up By Bow Degrees	PORT MAIN ENGINE				STBD MAIN ENGINE				Towline Pull (Lbs)
			SRPM	Torque (Ft Lbs)	HP	Fuel Con. (Gal/Hr)	SRPM	Torque (Ft Lbs)	HP	Fuel Con. (Gal/Hr)	
30	1350	1.5	420	1390	111	6.7	420	1160	93	6.5	5200
50	1620	4.5	479	2085	190	12.1	492	2570	241	14.4	11300
55	1830	7.0	543	3619	374	25.1	556	4681	495	19.3	17300
60	1800	8.0	533	4929	500	29.6	498	5400	512	26.7	19100
50	2000	8.0	591	4620	521	28.9	604	4923	566	30.6	19700

MSB-Coe-Halc-Cht.

TABLE B-VII. Noise Level - HALCYON

30 October 1985

CONFIGURATION:
- NO ENGINE OR GENERATOR COVERS
- ONE GENERATOR OPERATING
- RCS ON

WEATHER: 3 FT SWELLS
WIND 4 KTS

NOISE LEVELS - TWO ENGINES

Location	6.5 Kts at 1200 ERPM		12 Kts at 1350 ERPM		15 Kts at 1600 ERPM		19 Kts at 1900 ERPM	
	dB/A	dB/C	dB/A	dB/C	dB/A	dB/C	dB/A	dB/C
BRIDGE	64	79	66	83	68	86	73	92
MESS DECK	70	84	74	89	77	91	78	92
PASSENGER COMP. (unfinished)	73	85	77	89	80	92	82	94
OUTSIDE AFT MAIN DECK	94	100	97	104	99	106	100	107

NOISE LEVELS - ONE ENGINE (STBD)

Location	4.5 Kts at 1190 ERPM		10 Kts at 1650 ERPM		12.7 Kts at 1950 ERPM		13.2 Kts at 1900 ERPM	
	dB/A	dB/C	dB/A	dB/C	dB/A	dB/C	dB/A	dB/C
BRIDGE	62	77	65	86	66	86	68	86
MESS DECK	68	83	73	88	76	90	78	90
PASSENGER COMP. (unfinished)	71	85	75	88	77	90	79	90
OUTSIDE AFT MAIN DECK	93	98	95	103	97	105	98	104

MSB-Coe-Halc-Cht.

TABLE B-VIII. Vessel Performance Data

Single Engine Operations (Stbd)
30 October 1985

Ship Name: HALCYON
60' SWATH
RMI, Inc.

Main Engine: Caterpillar 3408 DI-TA
Horsepower: 510.0 Each
Red Gear Ratio: 3.01
Propellers: 45 In. Diameter, Cont. Pitch Reversible

Fuel (Gal.): 2460.0
Percent Usable: 98.0
Usable Fuel: 2410.8

Drafts: 7'3" Fwd
7'6" Aft
Disp.: 60.5 Lt

Speed (Kts)	Engine RPM	Shaft RPM	Propeller Pitch %	Stbd. Engine Net Flow (Gal/Hr)	Generator 25 KW Net Flow (Gal/Hr)	Total Fuel Consumption (Gal/Hr)	Range (NM)	Endurance (Days)	Fuel Efficiency (Gal/NM)
4.0	1190	364	30	3.9	1.0	4.9	1968	20.5	1.2
5.2	1360	400	35	6.4	1.0	7.4	1694	13.6	1.4
8.2	1360	416	45	8.9	1.0	9.9	1997	10.1	1.2
10.3	1650	516	50	13.0	1.0	14.0	1774	7.2	1.4
12.7	1950	592	60	23.0	1.0	24.0	1276	4.2	1.9
13.2	1900	556	70	28.8	1.0	29.8	1068	3.4	2.3

MSB-Coe-Halc-Cht.

Table B-IX. Vessel Performance Data

Two Engine Operations
30 October 1985

SHIP NAME: HALCYON (SD-60)
60' SWATH
RMI, Inc.

Main Engines: (2) Caterpillar 3408 DI-TA
Horsepower: 510 Each
Red Gear Ratio: 3.01
Propellers: 45 In. Diameter, Cont. Pitch Reversible

Fuel (Gal.): 2460.0
Percent Usable: 98.0
Usable Fuel: 2410.8

Drafts: 7'3" FWD
7'6" AFT
Disp.: 60.5 LT

Speed (Kts)	Mean Engine RPM	Mean Shaft RPM	Propeller Pitch (Percent)	Port Engine Net Flow (Gal/Hr)	Stbd. Engine Net Flow (Gal/Hr)	Generator 25 KW Net Flow (Gal/Hr)	Total Fuel Con-sumption (Gal/Hr)	Range (NM)	Endurance (Days)	Fuel Efficiency (Gal/NM)
6.6	1190	366	30	4.1	3.9	1.0	9.0	1768	11.2	1.4
12.0	1350	412	35	10.6	10.6	1.0	22.2	1303	4.5	1.8
12.5	1460	443	40	12.3	12.3	1.0	25.6	1177	3.9	2.0
15.5	1654	496	55	16.4	18.7	1.0	36.1	1035	2.8	2.3
17.5	1770	533	50	18.5	23.3	1.0	42.8	986	2.3	2.4
19.5	1820	550	65	22.0	26.6	1.0	49.6	948	2.0	2.5
20.5	1841	560	68	27.4	29.4	1.0	57.8	855	1.7	2.8

MSB-Coe-Halc-Cht.

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APPENDIX C

SHIP MOTION, WAVE AND RAO SPECTRA AND TABULAR DATA FOR SD-60 HALCYON AND USCGC PT KNOLL

- HALCYON SEAKEEPING TRIALS DATA IN 7.4 FT SEAS

  FIGURES C-1 to C-21
  TABLES C-I to C-XXI

- PT KNOLL SEAKEEPING TRIALS DATA IN 2.8 FT SEAS

  FIGURES C-22 to C-42
  TABLES C-XXII to C-XLII

- HALCYON AND PT KNOLL SEAKEEPING COMPARISONS USING RAOs IN 5 FT ISSC GENERATED SEAS

  FIGURES C-43 to C-63
  TABLES C-XLIII to C-LXIII

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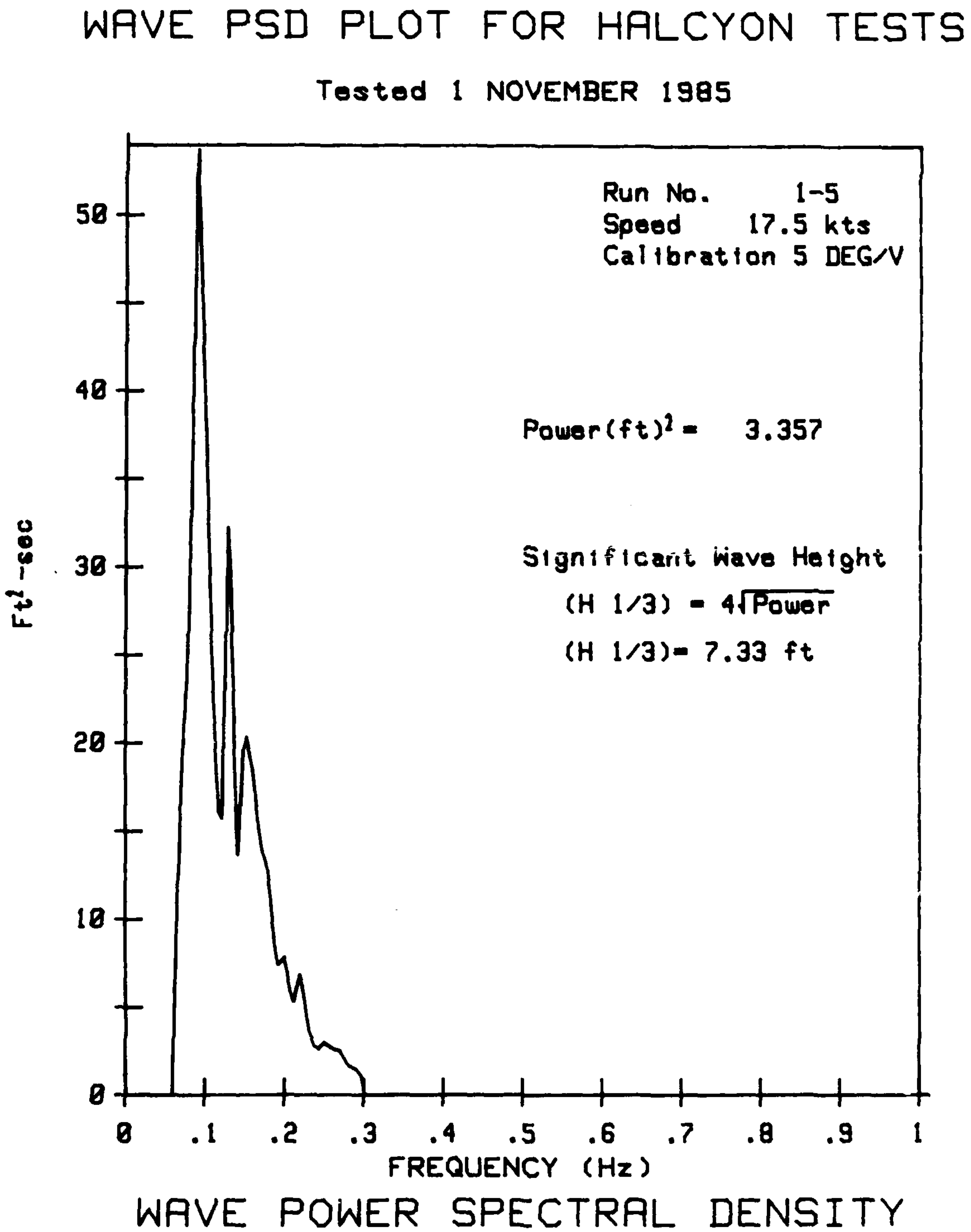


FIGURE C-1. Wave PSD Plot for HALCYON Seakeeping Tests, 1 November 1985

TABLE C-I
Wave PSD Data for HALCYON Seakeeping Tests
1 November 1985
7.4 Ft Significant Seas

CENTER FREQUENCY (Hz)	ENERGY DENSITY (FT-SQ/Hz)
.030	.00
.040	.26
.050	.00
.060	3.32
.070	17.68
.080	26.87
.090	54.18
.100	39.82
.110	22.88
.120	13.39
.130	34.57
.140	13.11
.150	20.89
.160	18.51
.170	14.09
.180	12.59
.190	7.31
.200	7.83
.210	5.07
.220	7.10
.230	3.67
.240	2.55
.250	2.98
.260	2.64
.270	2.49
.280	1.65
.290	1.47
.300	.87

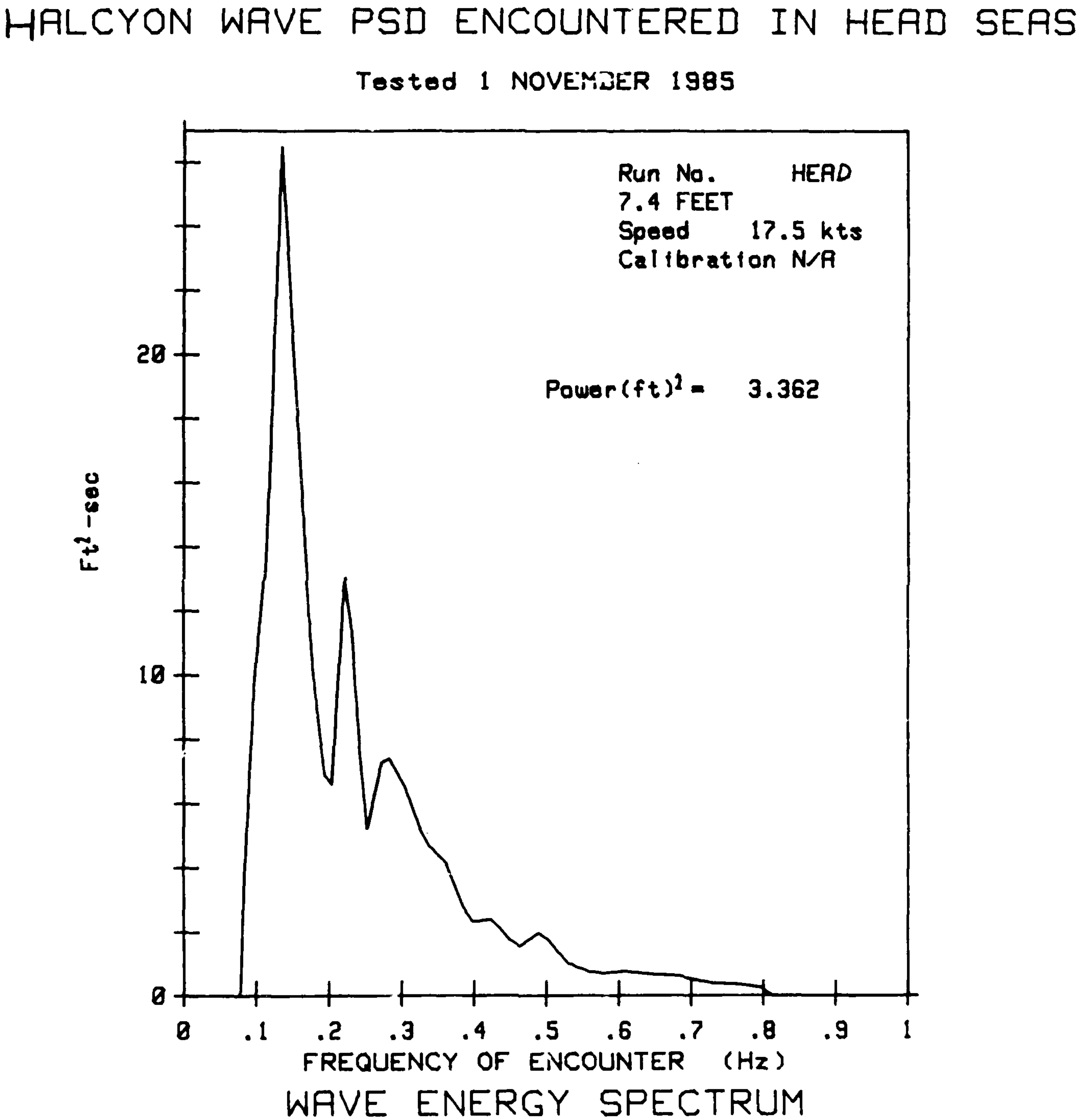


FIGURE C-2. HALCYON Wave PSD Encountered Plot,
7.4 Ft Head Seas

TABLE C-II
HALCYON Wave PSD Encountered
7.4 Ft Head Seas

HALCYON WAVE PSD ENCOUNTERED IN HEAD SEAS

Wave Energy Spectrum
Tested 1 NOVEMBER 1985

Run No. HEAD, Speed 17.5 , SEAS 7.4 FEET

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (FT SQR-SEC)
.047424	0.000000E+00
.112178	1.327575E+01
.134984	2.650130E+01
.194261	6.859052E+00
.203423	6.582788E+00
.222266	1.302946E+01
.251829	5.210182E+00
.282953	7.410545E+00
.293674	6.958309E+00
.397962	2.313892E+00
.410416	2.344698E+00
.544487	8.635228E-01
.573381	7.009692E-01
.695888	5.330306E-01
.864618	0.000000E+00
1.050678	0.000000E+00
1.254066	0.000000E+00
1.474785	0.000000E+00
1.712832	0.000000E+00
1.968209	0.000000E+00
2.240916	0.000000E+00
2.530952	0.000000E+00
2.838317	0.000000E+00
3.163012	0.000000E+00
3.505036	0.000000E+00
3.864389	0.000000E+00
4.241072	0.000000E+00
4.635084	0.000000E+00
5.046426	0.000000E+00
5.475097	0.000000E+00
5.921097	0.000000E+00
6.384427	0.000000E+00

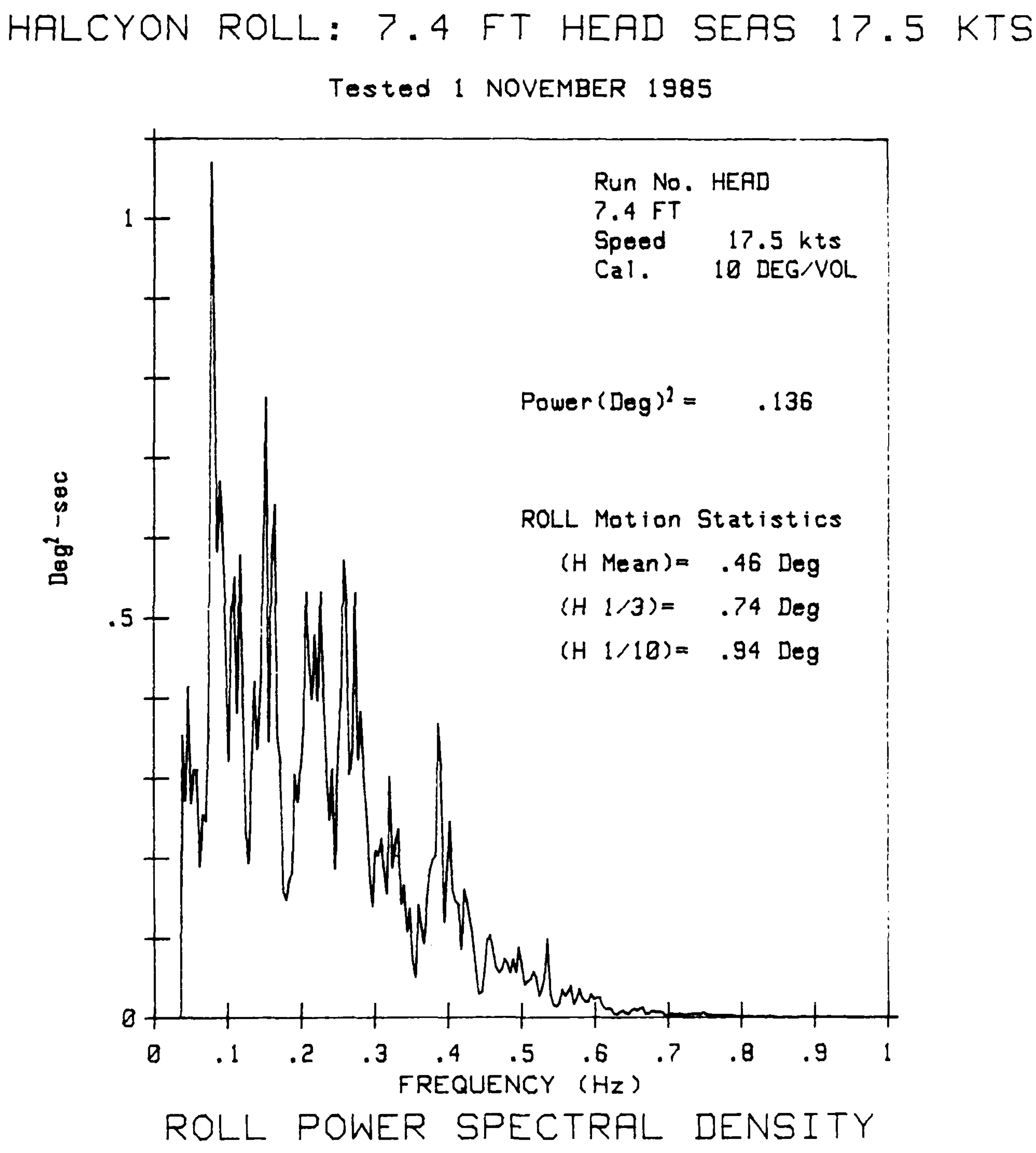


FIGURE C-3. HALCYON Roll PSD Plot, 7.4 Ft Head Seas

TABLE C-III
HALCYON Roll PSD
7.4 Ft Head Seas

HALCYON ROLL: 7.4 FT HEAD SEAS 17.5 KTS

ROLL Energy Spectrum
Tested 1 NOVEMBER 1985

Run No. HEAD, Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	3.527984E-01
.042969	2.720947E-01
.046875	4.143982E-01
.050781	2.678986E-01
.054688	3.107453E-01
.062500	1.891861E-01
.066406	2.544709E-01
.070313	2.468643E-01
.078125	1.069763E+00
.085938	5.814514E-01
.089844	6.708984E-01
.101563	3.209686E-01
.109375	5.511779E-01
.113281	3.811035E-01
.117188	5.787963E-01
.128906	1.929322E-01
.136719	4.203034E-01
.140625	3.358154E-01
.152344	7.751466E-01
.156250	3.451843E-01
.164063	6.408691E-01
.179688	1.475754E-01
.191406	3.049469E-01
.195313	2.704315E-01
.207031	5.317382E-01
.214844	3.980560E-01
.218750	4.785157E-01
.222656	3.962250E-01
.226563	5.322875E-01
.234375	3.166962E-01
.238281	2.474518E-01
.242188	3.107453E-01
.246094	1.858139E-01
.257813	5.719299E-01
.265625	3.041077E-01
.273438	5.314331E-01
.277344	3.225403E-01
.281250	3.829957E-01
.296875	1.392670E-01
.300781	2.090912E-01
.304688	2.036285E-01
.308594	2.240600E-01
.312500	1.874542E-01
.316406	1.555328E-01

TABLE C-III (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.320313	3.016510E-01
.324219	1.873779E-01
.332031	2.362595E-01
.335938	1.425247E-01
.339844	1.650010E-01
.343750	1.077843E-01
.347656	1.360931E-01
.351563	7.191467E-02
.355469	5.099678E-02
.359375	1.413040E-01
.386719	3.678283E-01
.390625	3.124694E-01
.394531	1.191711E-01
.402344	2.455368E-01
.417969	8.544541E-02
.421875	1.605453E-01
.429688	1.216011E-01
.441406	3.015709E-02
.457031	1.026649E-01
.468750	5.649376E-02
.503906	4.156875E-02
.507813	4.564475E-02
.535156	9.922790E-02
.546875	1.408720E-02
.585938	2.020074E-02
.625000	5.184890E-03
.664063	1.237726E-02
.703125	4.574776E-03
.742188	4.350901E-03
.781250	3.030658E-03
.820313	1.419008E-03
.859375	1.205206E-03
.898438	1.193345E-03
.937500	5.054176E-04
.976563	6.089211E-04

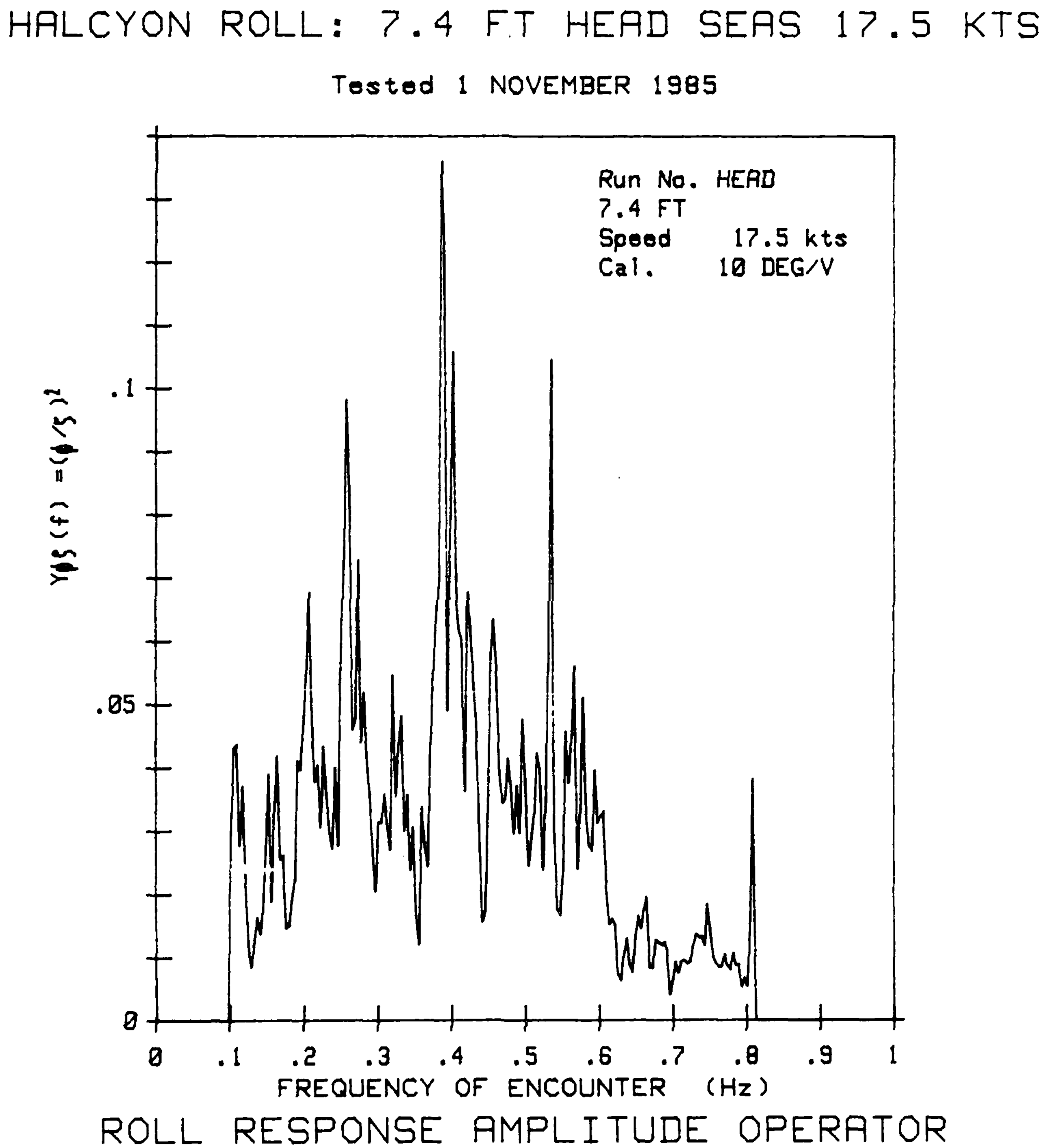


FIGURE C-4. HALCYON Roll RAO Plot, 7.4 Ft Head Seas

TABLE C-IV
HALCYON Roll RAO
7.4 Ft Head Seas

HALCYON ROLL: 7.4 FT HEAD SEAS 17.5 KTS

ROLL Response Amplitude Operator
Tested 1 NOVEMBER 1985

Run No. HEAD, Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE RAO
.039063	0.000000E+00
.078125	0.000000E+00
.109375	4.357203E-02
.113281	2.764202E-02
.117188	3.710723E-02
.128906	8.475122E-03
.136719	1.625657E-02
.152344	3.896339E-02
.156250	1.877396E-02
.164063	4.181173E-02
.167969	2.548874E-02
.171875	2.596795E-02
.175781	1.455370E-02
.191406	4.113010E-02
.195313	3.961001E-02
.207031	6.772235E-02
.214844	3.769587E-02
.218750	4.034845E-02
.222656	3.057158E-02
.226563	4.337463E-02
.234375	3.025199E-02
.238281	2.720795E-02
.242188	4.007061E-02
.246094	2.763455E-02
.257813	9.809693E-02
.265625	4.592696E-02
.273438	7.278492E-02
.277344	4.390563E-02
.281250	5.181908E-02
.296875	2.040148E-02
.300781	3.137036E-02
.304688	3.132003E-02
.308594	3.582610E-02
.312500	3.120774E-02
.316406	2.699548E-02
.320313	5.459484E-02
.324219	3.542723E-02
.332031	4.807837E-02
.335938	2.999499E-02
.339844	3.572667E-02
.343750	2.379576E-02
.347656	3.064685E-02
.351563	1.651886E-02
.355469	1.194726E-02
.359375	3.377654E-02
.367188	2.437969E-02
.386719	1.358886E-01
.390625	1.215686E-01
.394531	4.896524E-02
.402344	1.056194E-01

TABLE C-IV (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE
.417969	3.616550E-02
.421875	6.768660E-02
.429688	5.453496E-02
.441406	1.549342E-02
.457031	6.343671E-02
.468750	3.429506E-02
.476563	4.158381E-02
.484375	2.957634E-02
.488281	3.720133E-02
.492188	2.968887E-02
.496094	4.771539E-02
.503906	2.441653E-02
.507813	2.868724E-02
.515625	4.229978E-02
.523438	2.383558E-02
.535156	1.044943E-01
.546875	1.672502E-02
.554688	4.571228E-02
.558594	3.760457E-02
.566406	5.603419E-02
.570313	2.399802E-02
.578125	5.109166E-02
.585938	2.761427E-02
.589844	2.693713E-02
.593750	3.966265E-02
.597656	3.125605E-02
.605469	3.304975E-02
.613281	1.516280E-02
.617188	1.601078E-02
.625000	7.305610E-03
.628906	6.324641E-03
.652344	1.652383E-02
.656250	1.454363E-02
.664063	1.956074E-02
.671875	8.297877E-03
.703125	9.239825E-03
.742188	1.181243E-02
.746094	1.841066E-02
.761719	8.517033E-03
.781250	1.058710E-02
.808594	3.820891E-02
.812500	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

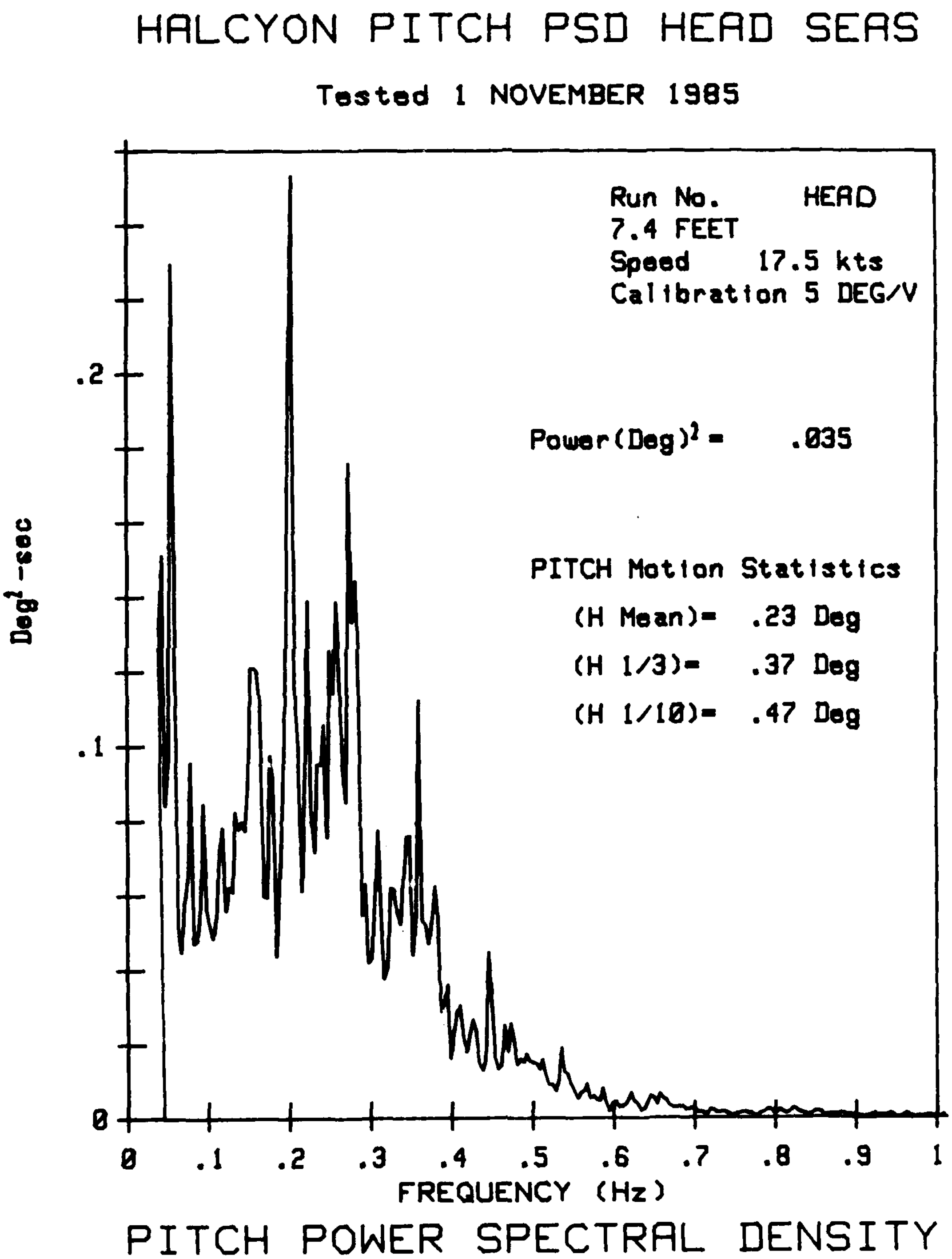


FIGURE C-5. HALCYON Pitch PSD Plot, 7.4 Ft Head Seas

TABLE C-V
HALCYON Pitch PSD, 7.4 Ft Head Seas

HALCYON PITCH PSD HEAD SEAS

PITCH Energy Spectrum
Tested 1 NOVEMBER 1985

Run No. HEAD, Speed 17.5 , SEAS 7.4 FEET

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.054688	2.296294E-01
.066406	4.473496E-02
.078125	9.561539E-02
.082031	4.700661E-02
.093750	8.454133E-02
.105469	4.837798E-02
.117188	7.796859E-02
.121094	5.577088E-02
.125000	6.207848E-02
.128906	6.111717E-02
.132813	8.233261E-02
.136719	7.786179E-02
.140625	7.961654E-02
.144531	7.736587E-02
.156250	1.209602E-01
.171875	5.937958E-02
.175781	9.741974E-02
.183594	4.338454E-02
.195313	1.182289E-01
.203125	2.532043E-01
.214844	6.103325E-02
.222656	1.389313E-01
.230469	7.143784E-02
.234375	9.513093E-02
.238281	9.510803E-02
.242188	1.056442E-01
.246094	7.546997E-02
.250000	1.255875E-01
.253906	1.139145E-01
.257813	1.386261E-01
.269531	8.485794E-02
.273438	1.758042E-01
.277344	1.329346E-01
.281250	1.442490E-01
.289063	5.439186E-02
.292969	6.284333E-02
.296875	4.174995E-02
.308594	7.718277E-02
.312500	5.405426E-02
.316406	3.742790E-02
.324219	6.182861E-02
.335938	5.210686E-02
.347656	7.589722E-02
.351563	4.375458E-02
.359375	1.121788E-01
.371094	4.674149E-02
.378906	6.228256E-02
.386719	2.839661E-02
.390625	3.080558E-02

TABLE C-V (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.394531	3.576661E-02
.398438	1.610947E-02
.410156	3.025531E-02
.425781	2.648544E-02
.429688	2.373886E-02
.437500	1.296949E-02
.445313	4.464531E-02
.457031	1.311779E-02
.468750	1.812554E-02
.507813	1.324511E-02
.546875	9.078026E-03
.585938	8.155346E-03
.625000	4.441738E-03
.664063	4.793643E-03
.703125	1.752437E-03
.742188	1.088560E-03
.781250	1.450062E-03
.820313	2.462626E-03
.859375	8.733571E-04
.898438	9.030998E-04
.937500	9.253026E-04
.976563	7.142424E-04

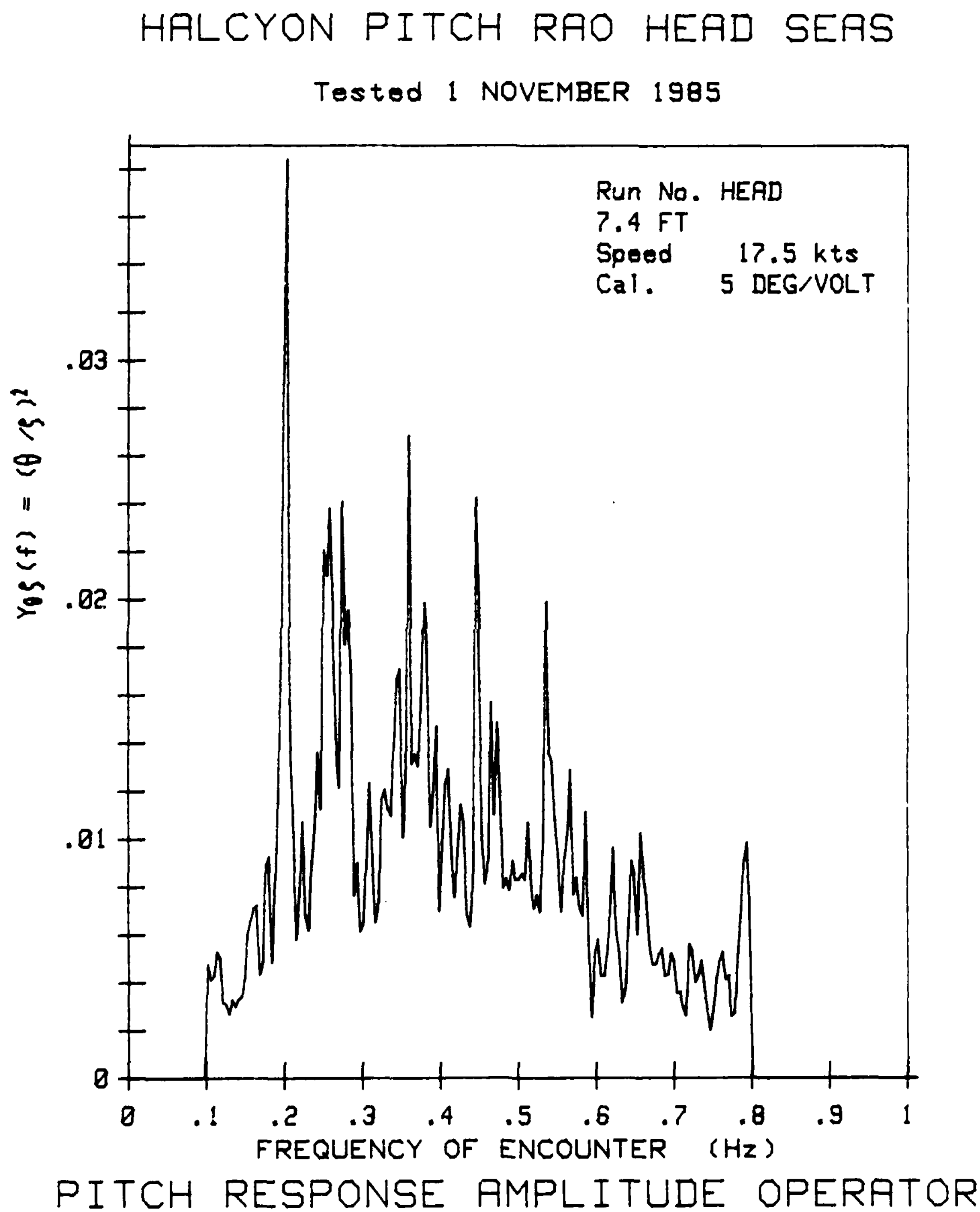


FIGURE C-6. HALCYON Pitch RAO Plot, 7.4 Ft Head Seas

TABLE C-VI
HALCYON Pitch RAO
7.4 Ft Head Seas

HALCYON PITCH RAO HEAD SEAS

PITCH Response Amplitude Operator
Tested 1 NOVEMBER 1985

Run No. HEAD, Speed 17.5 , SEAS 7.4 FT

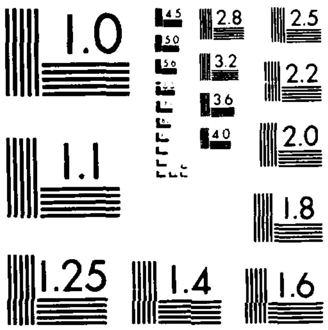
FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE RAO
.039063	0.000000E+00
.078125	0.000000E+00
.101563	4.736879E-03
.105469	4.107642E-03
.113281	5.264224E-03
.117188	4.998646E-03
.128906	2.684754E-03
.156250	6.578812E-03
.164063	7.196844E-03
.167969	4.317154E-03
.179688	9.258637E-03
.183594	4.824619E-03
.195313	1.731695E-02
.203125	3.841221E-02
.214844	5.779844E-03
.222656	1.071954E-02
.230469	6.167389E-03
.234375	9.087257E-03
.242188	1.362282E-02
.246094	1.122402E-02
.250000	2.205999E-02
.253906	2.099642E-02
.257813	2.377703E-02
.269531	1.211144E-02
.273438	2.407808E-02
.277344	1.809565E-02
.281250	1.951680E-02
.289063	7.604247E-03
.292969	8.992967E-03
.296875	6.116030E-03
.308594	1.234115E-02
.312500	8.999056E-03
.316406	6.496277E-03
.328125	1.207008E-02
.335938	1.096613E-02
.347656	1.709132E-02
.351563	1.005046E-02
.359375	2.681461E-02
.363281	1.310289E-02
.367188	1.353622E-02
.371094	1.301867E-02
.378906	1.985192E-02
.386719	1.049070E-02
.390625	1.198514E-02
.394531	1.469584E-02
.398438	6.958528E-03
.410156	1.290725E-02
.417969	7.540200E-03
.425781	1.144100E-02
.429688	1.064627E-02

TABLE C-VI (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE
.437500	6.323036E-03
.445313	2.424084E-02
.457031	8.105488E-03
.464844	1.572580E-02
.468750	1.100327E-02
.472656	1.485371E-02
.480469	7.928909E-03
.484375	8.340231E-03
.488281	7.819688E-03
.492188	9.088705E-03
.496094	8.311253E-03
.503906	8.557102E-03
.507813	8.324407E-03
.511719	1.069714E-02
.519531	7.090301E-03
.523438	7.659219E-03
.527344	6.949314E-03
.535156	1.990703E-02
.546875	1.077788E-02
.554688	6.954273E-03
.566406	1.289499E-02
.570313	7.657247E-03
.574219	8.372021E-03
.582031	6.795359E-03
.585938	1.114830E-02
.593750	2.520952E-03
.601563	5.813149E-03
.605469	4.241755E-03
.621094	9.629027E-03
.625000	6.258494E-03
.632813	3.148101E-03
.644531	9.084565E-03
.652344	6.003425E-03
.656250	1.027914E-02
.664063	7.575765E-03
.671875	4.753223E-03
.683594	5.415571E-03
.687500	4.256419E-03
.695313	5.193870E-03
.703125	3.539454E-03
.714844	2.609673E-03
.718750	5.609295E-03
.726563	3.994728E-03
.734375	4.914620E-03
.742188	2.955374E-03
.746094	2.008562E-03
.761719	5.270023E-03
.765625	4.141450E-03
.769531	4.248934E-03
.781250	5.065549E-03
.792969	9.825853E-03
.800781	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

AD-A190 995 TECHNICAL EVALUATION OF THE 60 FOOT SMALL WATERPLANE AREA TWIN HULL (SWAT..(U) COAST GUARD WASHINGTON DC OFFICE OF RESEARCH AND DEVELOPMENT.. T J COE AUG 87 2/3

UNCLASSIFIED USCG-D-08-88 F/G 13/10 NL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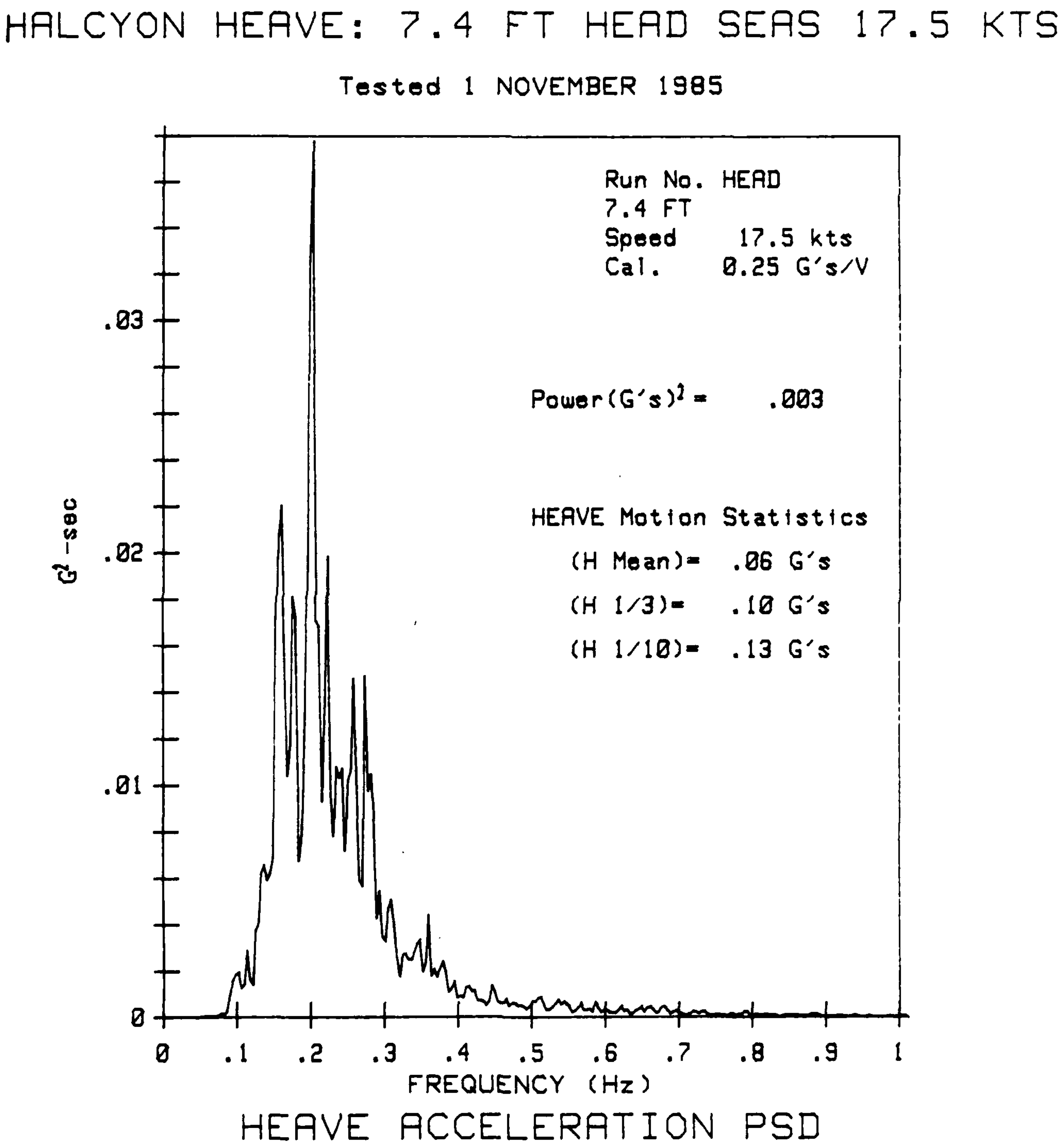


FIGURE C-7. HALCYON Heave PSD Plot, 7.4 Ft Head Seas

TABLE C-VII
HALCYON Heave PSD
7.4 Ft Head Seas

HALCYON HEAVE: 7.4 FT HEAD SEAS 17.5 KTS

HEAVE Energy Spectrum
Tested 1 NOVEMBER 1985

Run No. HEAD, Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.039063	3.984198E-06
.054688	5.376898E-05
.078125	1.619830E-04
.113281	2.886296E-03
.117188	1.624405E-03
.136719	6.576061E-03
.140625	5.914211E-03
.156250	2.074338E-02
.160156	2.200603E-02
.167969	1.038551E-02
.175781	1.812171E-02
.183594	6.718158E-03
.195313	1.942920E-02
.203125	3.778648E-02
.214844	9.282589E-03
.222656	1.983357E-02
.230469	7.789850E-03
.234375	1.079035E-02
.238281	1.032305E-02
.242188	1.072025E-02
.246094	7.149696E-03
.257813	1.459980E-02
.269531	5.653381E-03
.273438	1.469994E-02
.277344	9.747029E-03
.281250	1.046419E-02
.289063	4.250526E-03
.292969	5.445003E-03
.300781	3.287674E-03
.308594	5.071640E-03
.312500	4.015685E-03
.320313	1.742184E-03
.351563	1.953125E-03
.359375	4.411221E-03
.363281	1.771211E-03
.390625	1.252949E-03
.429688	7.093549E-04
.468750	4.992187E-04
.507813	8.204877E-04
.546875	5.738139E-04
.585938	6.685853E-04
.625000	2.877117E-04
.664063	3.521293E-04
.703125	1.512840E-04
.742188	9.501354E-05
.781250	1.457781E-04
.820313	1.159795E-04
.859375	9.870530E-05
.898438	3.946386E-05
.937500	1.024865E-04

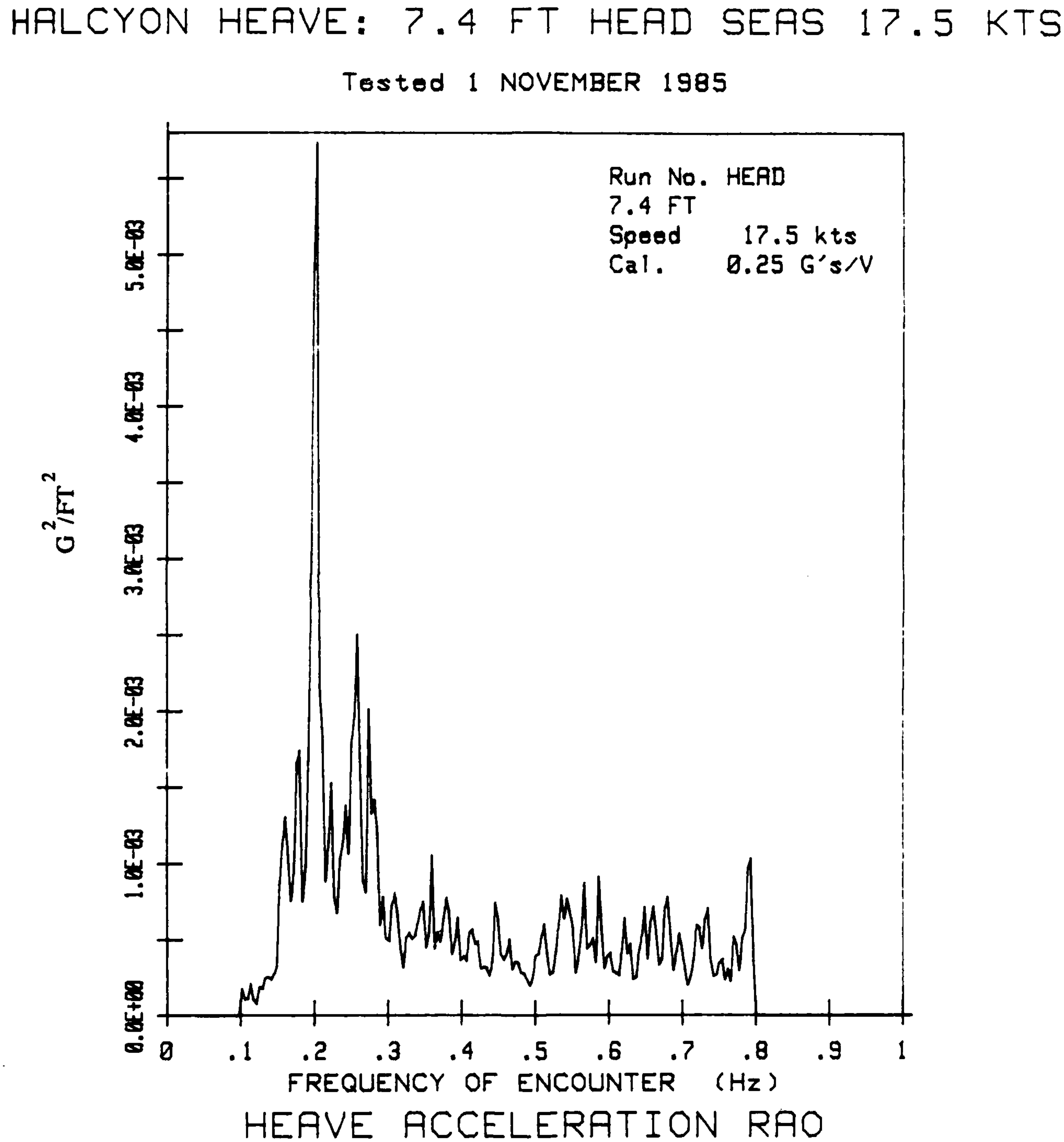


FIGURE C-8. HALCYON Heave RAO Plot, 7.4 Ft Head Seas

TABLE C-VIII
HALCYON Heave RAO
7.4 Ft Head Seas

HALCYON HEAVE: 7.4 FT HEAD SEAS 17.5 KTS

HEAVE Response Amplitude Operator
Tested 1 NOVEMBER 1985

Run No. HEAD, Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	G^2/FT^2
.039063	0.000000E+00
.078125	0.000000E+00
.117188	1.041423E-04
.156250	1.128195E-03
.160156	1.304365E-03
.167969	7.532576E-04
.179688	1.742985E-03
.183594	7.470991E-04
.195313	2.845788E-03
.203125	5.732375E-03
.214844	8.790604E-04
.222656	1.530301E-03
.230469	6.725151E-04
.234375	1.030734E-03
.242188	1.382377E-03
.246094	1.063315E-03
.257813	2.504145E-03
.269531	8.068849E-04
.273438	2.013299E-03
.277344	1.326809E-03
.281250	1.415799E-03
.289063	5.942444E-04
.292969	7.791875E-04
.308594	8.109304E-04
.312500	6.685389E-04
.320313	3.153122E-04
.347656	7.499892E-04
.351563	4.486343E-04
.359375	1.054434E-03
.363281	4.384429E-04
.378906	7.755513E-04
.386719	4.016454E-04
.390625	4.874694E-04
.394531	6.404500E-04
.425781	3.097436E-04
.429688	3.181274E-04
.445313	7.435129E-04
.457031	3.683710E-04
.468750	3.030553E-04
.507813	5.156077E-04
.511719	6.002759E-04
.519531	2.672173E-04
.535156	7.904388E-04
.539063	6.306834E-04
.542969	7.675999E-04
.546875	6.812603E-04
.554688	2.755341E-04
.566406	8.720460E-04
.570313	4.359774E-04
.585938	9.139514E-04

TABLE C-VIII (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	G^2/FT^2
.593750	3.060799E-04
.621094	6.418151E-04
.625000	4.053913E-04
.632813	2.380887E-04
.648438	7.139358E-04
.652344	3.719314E-04
.660156	7.157396E-04
.664063	5.564971E-04
.667969	3.320289E-04
.679688	7.798590E-04
.687500	2.948163E-04
.703125	3.055533E-04
.718750	5.959224E-04
.734375	7.055852E-04
.742188	2.579560E-04
.781250	5.092514E-04
.792969	1.032443E-03
.800781	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

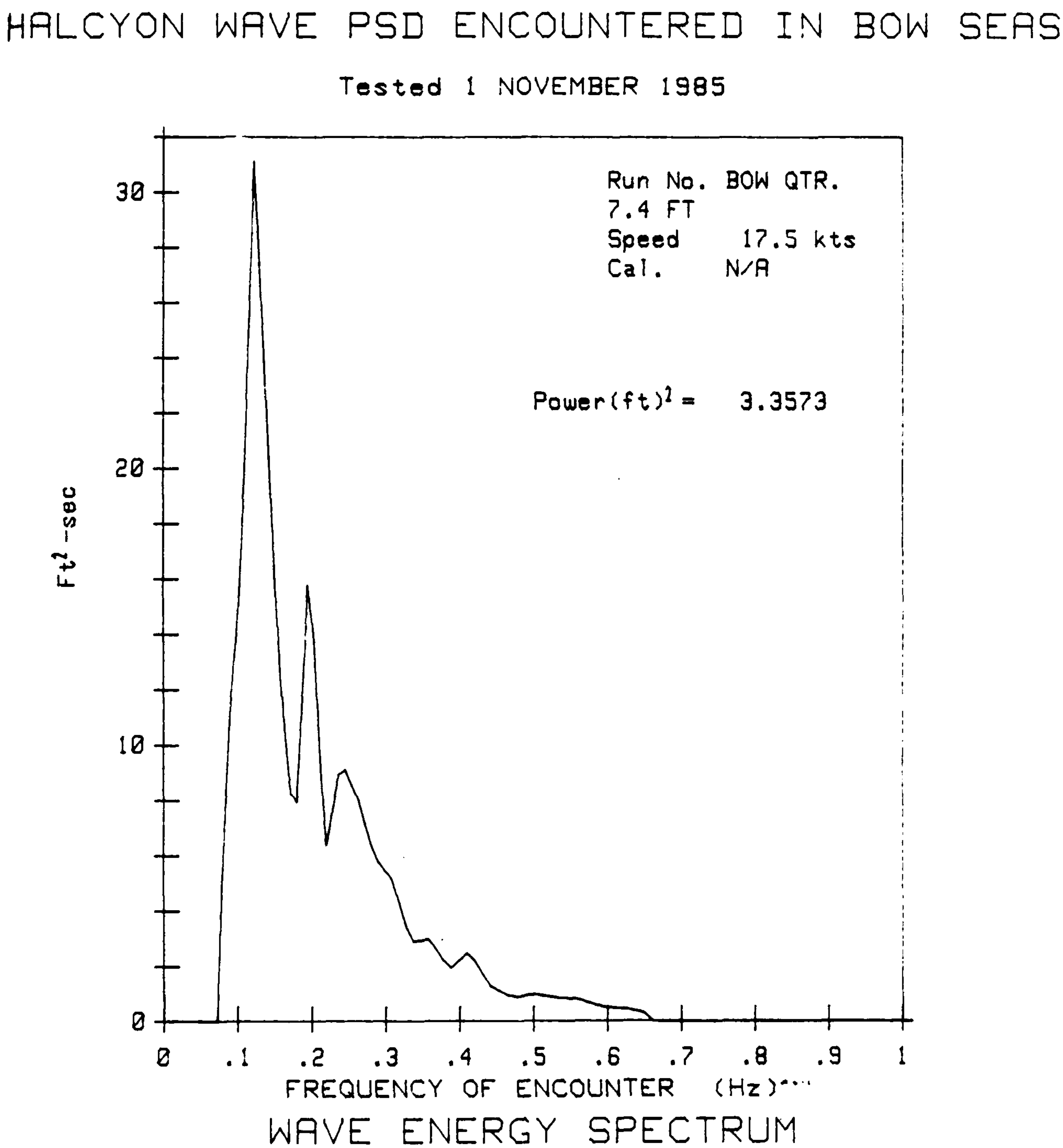


FIGURE C-9. HALCYON Wave PSD Encountered Plot, 7.4 Ft Bow Seas

TABLE C-IX
HALCYON Wave PSD Encountered
7.4 Ft Bow Seas

HALCYON WAVE PSD ENCOUNTERED IN BOW SEAS

Wave Energy Spectrum
Tested 1 NOVEMBER 1985

Run No. BOW QTR., Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (FT SQR-SEC)
.044887	0.000000E+00
.102027	1.540586E+01
.121558	3.112278E+01
.171421	8.242016E+00
.179034	7.932394E+00
.194629	1.578511E+01
.218939	6.358955E+00
.244352	9.105445E+00
.253069	8.567795E+00
.337029	2.896347E+00
.346970	2.939574E+00
.453125	1.097734E+00
.475827	8.932322E-01
.571534	6.851023E-01
.702197	0.000000E+00
.845113	0.000000E+00
1.000283	0.000000E+00
1.167707	0.000000E+00
1.347385	0.000000E+00
1.539316	0.000000E+00
1.743501	0.000000E+00
1.959940	0.000000E+00
2.188632	0.000000E+00
2.429579	0.000000E+00
2.682779	0.000000E+00
2.948232	0.000000E+00
3.225940	0.000000E+00
3.515901	0.000000E+00
3.818116	0.000000E+00
4.132584	0.000000E+00
4.459307	0.000000E+00
4.798283	0.000000E+00

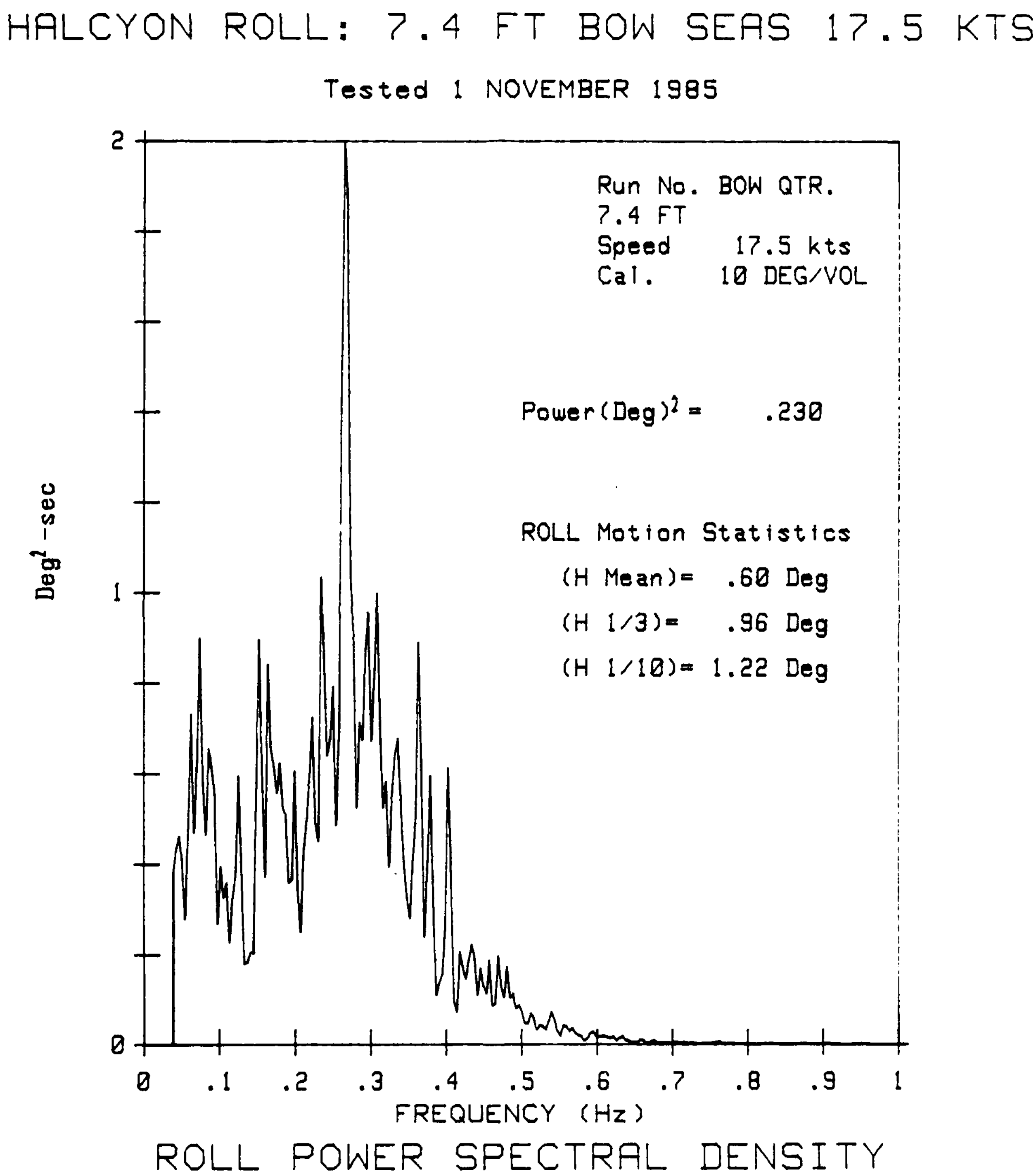


FIGURE C-10. HALCYON Roll PSD Plot, 7.4 Ft Bow Seas

TABLE C-X
HALCYON Roll PSD
7.4 Ft Bow Seas

HALCYON ROLL: 7.4 FT BOW SEAS 17.5 KTS

ROLL Energy Spectrum
Tested 1 NOVEMBER 1985

Run No. BOW QTR., Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	3.817291E-01
.046875	4.615784E-01
.054688	2.779389E-01
.062500	7.312928E-01
.066406	4.691010E-01
.074219	8.996582E-01
.078125	5.863037E-01
.082031	4.652253E-01
.085938	6.549683E-01
.097656	2.666474E-01
.101563	3.943024E-01
.105469	3.240051E-01
.109375	3.579406E-01
.113281	2.271882E-01
.117188	3.254090E-01
.125000	5.955811E-01
.132813	1.782685E-01
.140625	2.042770E-01
.144531	2.035523E-01
.152344	8.966064E-01
.156250	6.223450E-01
.160156	3.710632E-01
.164063	8.415832E-01
.175781	5.569763E-01
.179688	6.230163E-01
.191406	3.573150E-01
.195313	3.657227E-01
.199219	6.050110E-01
.207031	2.487259E-01
.222656	7.246704E-01
.230469	4.502869E-01
.234375	1.034363E+00
.242188	6.387024E-01
.250000	7.924499E-01
.253906	4.851837E-01
.265625	1.998291E+00
.273438	1.053040E+00
.281250	5.244141E-01
.285156	7.130738E-01
.289063	6.744384E-01
.296875	9.566040E-01
.300781	6.718750E-01
.308594	9.982299E-01
.312500	7.063293E-01
.316406	5.243226E-01
.320313	5.828246E-01
.324219	3.934478E-01
.335938	6.774902E-01
.351563	2.814179E-01
.363281	8.904725E-01

TABLE C-X (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.371094	2.377166E-01
.378906	5.964966E-01
.386719	1.086922E-01
.390625	1.372299E-01
.402344	6.135254E-01
.414063	7.158661E-02
.417969	2.056122E-01
.429688	1.867904E-01
.433594	2.216568E-01
.441406	1.094818E-01
.468750	1.984710E-01
.507813	4.757691E-02
.546875	3.140259E-02
.585938	1.285791E-02
.625000	1.007032E-02
.652344	5.182742E-03
.664063	3.928899E-03
.703125	6.075144E-03
.742188	3.022194E-03
.781250	2.292872E-03
.820313	2.548218E-03
.859375	1.410663E-03
.898438	1.624584E-03
.937500	1.197696E-03
.976563	8.164048E-04

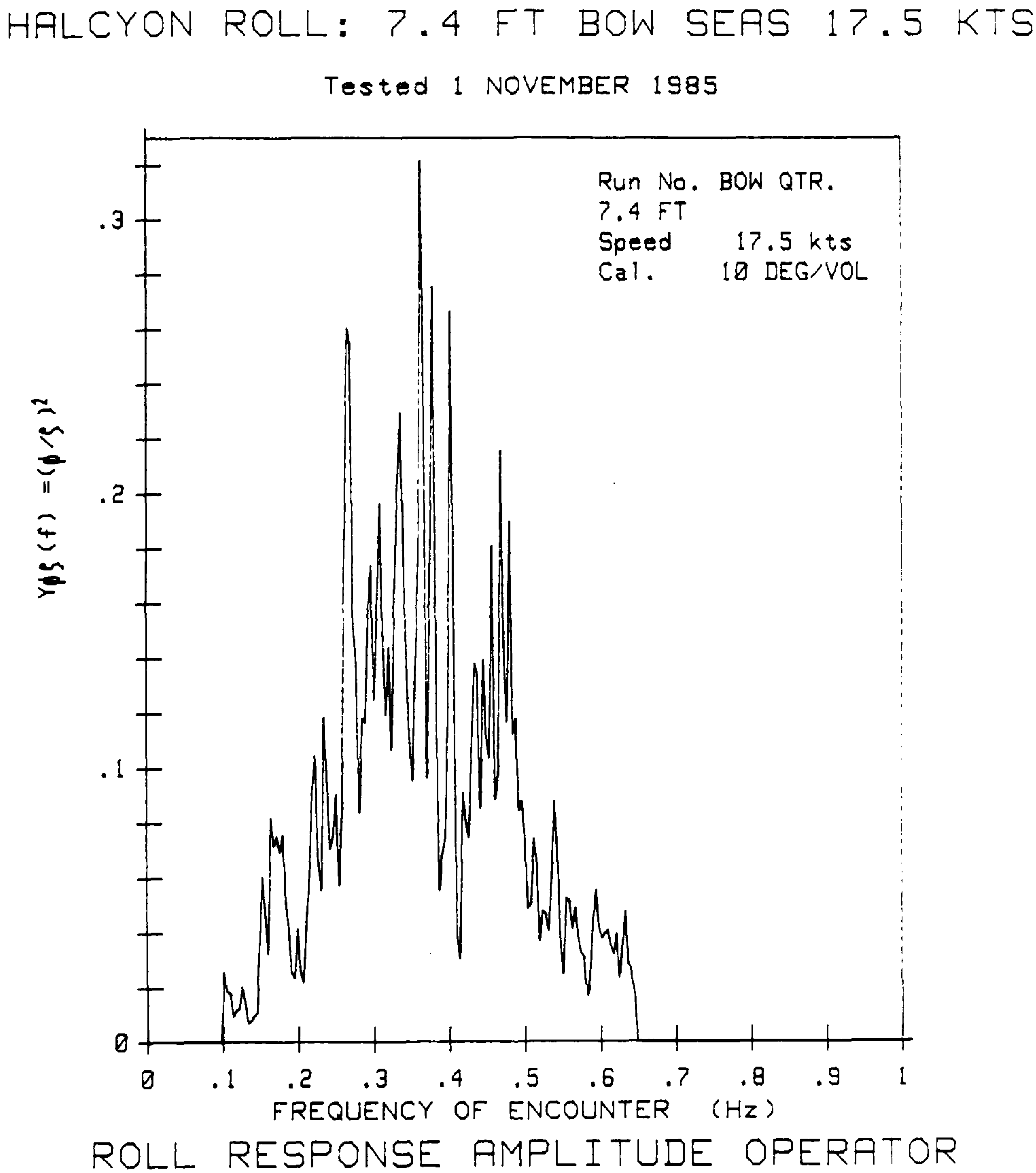


FIGURE C-11. HALCYON Roll RAO Plot, 7.4 Ft Bow Seas

TABLE C-XI
HALCYON Roll RAO
7.4 Ft Bow Seas

HALCYON ROLL: 7.4 FT BOW SEAS 17.5 KTS

ROLL Response Amplitude Operator
Tested 1 NOVEMBER 1985

Run No. BOW QTR., Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE RAO
.039063	0.000000E+00
.078125	0.000000E+00
.101563	2.583522E-02
.117188	1.189398E-02
.132813	7.025477E-03
.152344	6.016505E-02
.156250	4.838969E-02
.160156	3.217104E-02
.164063	8.190356E-02
.167969	7.124046E-02
.171875	7.499188E-02
.175781	6.906361E-02
.179688	7.534195E-02
.195313	2.342741E-02
.199219	4.139408E-02
.207031	2.168844E-02
.222656	1.043992E-01
.230469	5.529038E-02
.234375	1.184855E-01
.242188	7.047277E-02
.250000	9.049250E-02
.253906	5.696697E-02
.265625	2.602581E-01
.273438	1.516008E-01
.281250	8.362575E-02
.285156	1.183309E-01
.289063	1.166600E-01
.296875	1.735237E-01
.300781	1.248147E-01
.308594	1.960788E-01
.312500	1.488540E-01
.316406	1.191840E-01
.320313	1.439374E-01
.324219	1.064135E-01
.335938	2.292366E-01
.351563	9.511148E-02
.363281	3.215564E-01
.371094	9.615694E-02
.378906	2.752492E-01
.386719	5.506637E-02
.390625	6.825692E-02
.402344	2.663142E-01
.414063	3.042565E-02
.417969	9.106360E-02
.425781	7.474336E-02
.429688	1.057041E-01
.433594	1.383306E-01
.441406	8.520205E-02
.445313	1.396648E-01
.453125	1.037025E-01

TABLE C-XI (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE
.457031	1.810209E-01
.460938	8.836651E-02
.468750	2.157162E-01
.476563	1.165933E-01
.480469	1.899258E-01
.484375	1.122810E-01
.488281	1.179284E-01
.492188	8.427289E-02
.496094	8.813569E-02
.503906	4.877290E-02
.507813	5.031425E-02
.511719	7.431044E-02
.519531	3.680565E-02
.523438	4.789361E-02
.531250	4.048950E-02
.539063	8.796891E-02
.546875	3.870383E-02
.550781	2.459116E-02
.554688	5.258501E-02
.562500	4.132604E-02
.566406	4.890789E-02
.582031	1.678568E-02
.585938	2.274678E-02
.593750	5.547714E-02
.601563	3.768116E-02
.609375	4.060170E-02
.621094	3.940277E-02
.625000	2.328385E-02
.632813	4.774585E-02
.648438	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

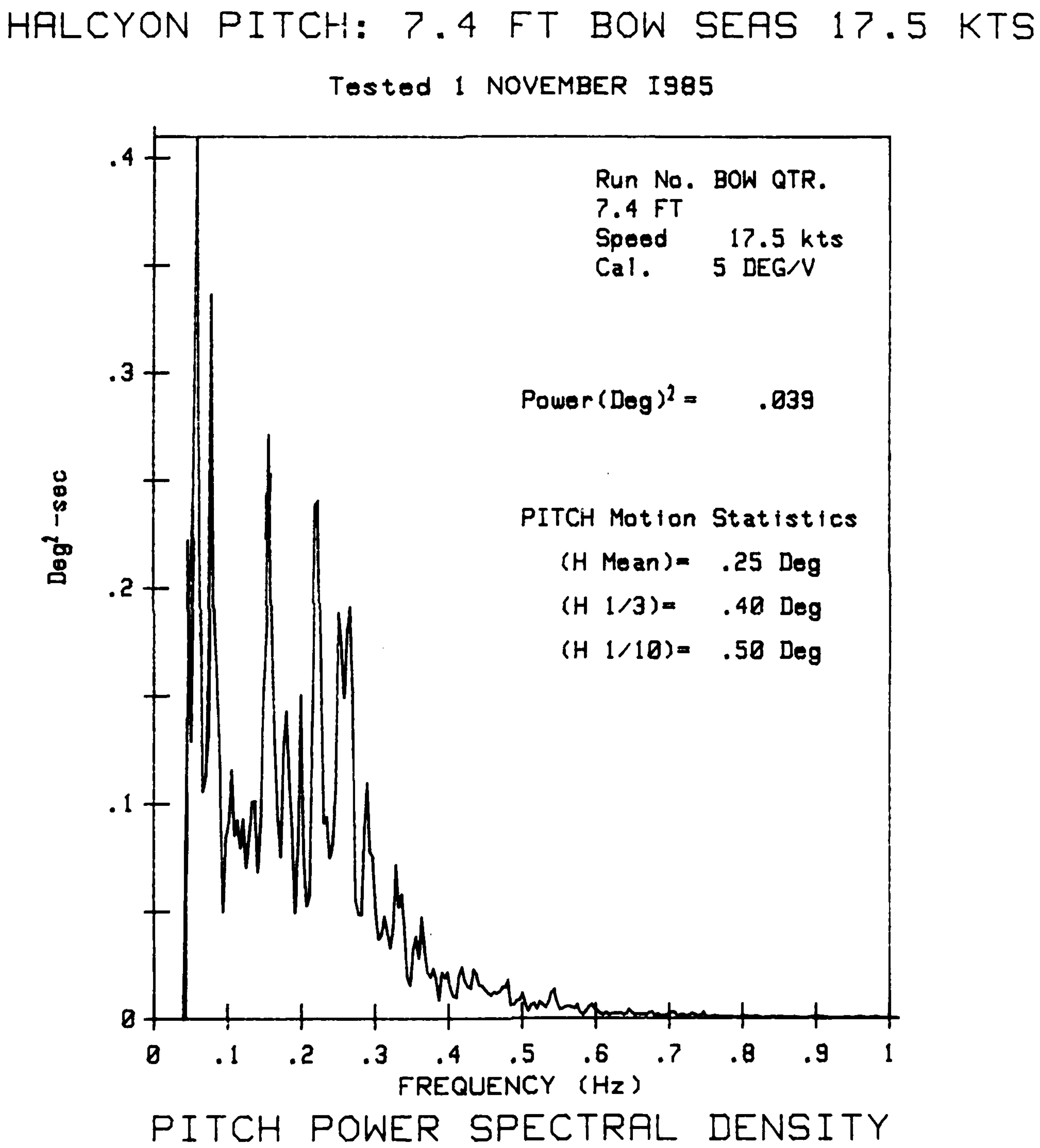


FIGURE C-12. HALCYON Pitch PSD Plot, 7.4 Ft Bow Seas

TABLE C-XII
HALCYON Pitch PSD
7.4 Ft Bow Seas

HALCYON PITCH: 7.4 FT BOW SEAS 17.5 KTS

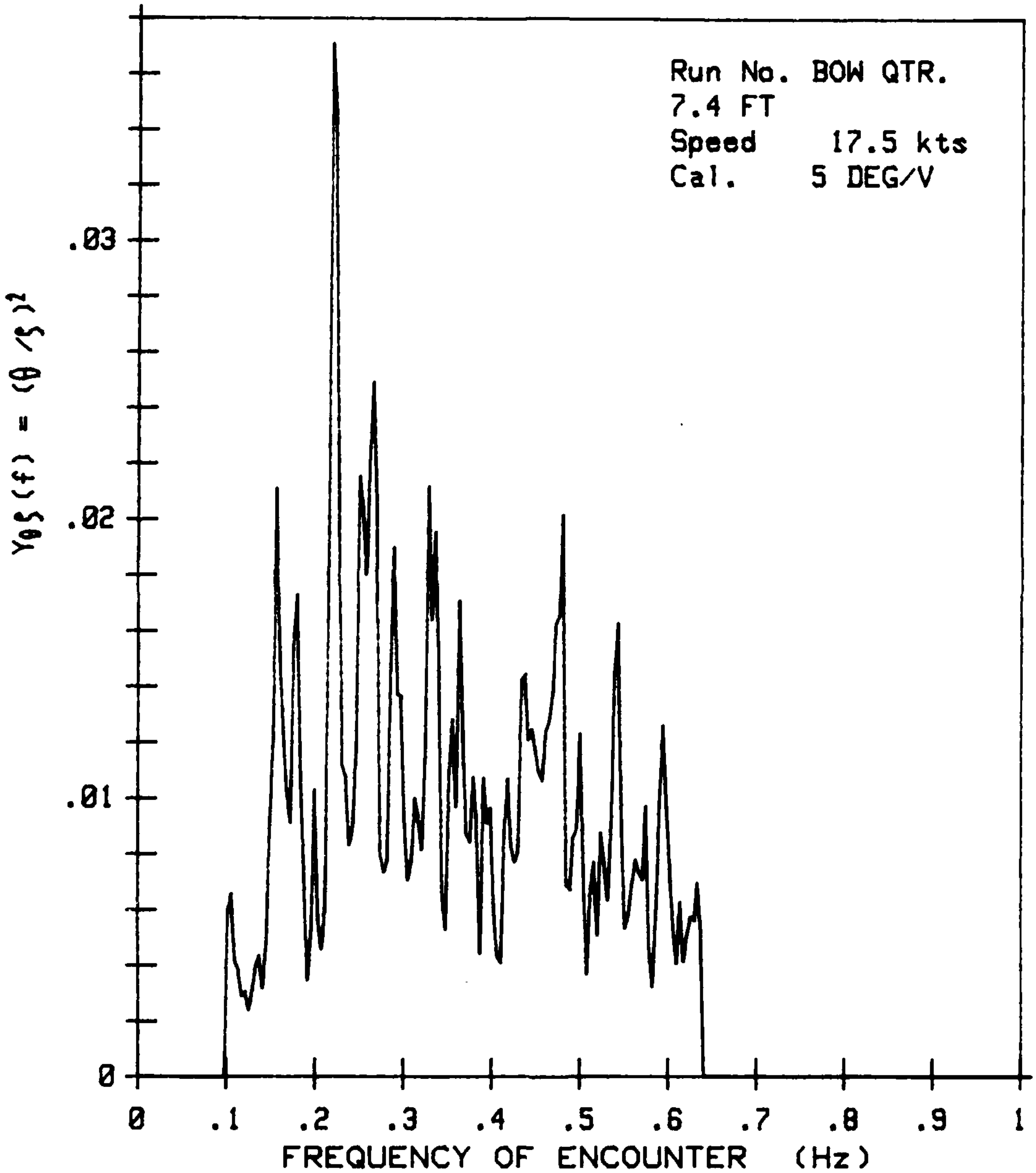
PITCH Energy Spectrum
Tested 1 NOVEMBER 1985

Run No. BOW QTR., Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.046875	2.225037E-01
.050781	1.286774E-01
.058594	4.096680E-01
.066406	1.054382E-01
.078125	3.364715E-01
.093750	4.961586E-02
.105469	1.155930E-01
.109375	8.509445E-02
.113281	9.204483E-02
.117188	7.942200E-02
.121094	9.281539E-02
.125000	7.020950E-02
.136719	1.011238E-01
.140625	6.806182E-02
.156250	2.712861E-01
.171875	7.501602E-02
.179688	1.430512E-01
.191406	4.903411E-02
.195313	8.135224E-02
.199219	1.505051E-01
.207031	5.257987E-02
.222656	2.402573E-01
.230469	9.080506E-02
.234375	9.380341E-02
.238281	7.459640E-02
.250000	1.886902E-01
.257813	1.490173E-01
.265625	1.910706E-01
.273438	5.537987E-02
.277344	4.832077E-02
.289063	1.098137E-01
.304688	3.704643E-02
.312500	4.749107E-02
.328125	7.151795E-02
.332031	5.183792E-02
.335938	5.773734E-02
.347656	1.550770E-02
.351563	3.276062E-02
.355469	3.815842E-02
.363281	4.732131E-02
.375000	1.943493E-02
.390625	2.156448E-02
.429688	1.429987E-02
.468750	1.262903E-02
.507813	3.471851E-03
.546875	7.887840E-03
.585938	3.386616E-03
.625000	2.486944E-03
.664063	2.139450E-03

HALCYON PITCH: 7.4 FT BOW SEAS 17.5 KTS

Tested 1 NOVEMBER 1985



PITCH RESPONSE AMPLITUDE OPERATOR

FIGURE C-13. HALCYON Pitch RAO Plot, 7.4 Ft Bow Seas

TABLE C-XIII
HALCYON Pitch RAO
7.4 Ft Bow Seas

HALCYON PITCH: 7.4 FT BOW SEAS 17.5 KTS

PITCH Response Amplitude Operator
Tested 1 NOVEMBER 1985

Run No. BOW QTR., Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE RAO
.039063	0.000000E+00
.078125	0.000000E+00
.105469	6.566854E-03
.117188	2.902944E-03
.136719	4.338173E-03
.156250	2.109352E-02
.171875	9.122100E-03
.179668	1.729931E-02
.191406	3.452999E-03
.195313	5.211250E-03
.199219	1.029736E-02
.207031	4.584868E-03
.218750	3.706847E-02
.234375	1.074511E-02
.238281	8.300738E-03
.250000	2.154717E-02
.257813	1.799786E-02
.265625	2.488509E-02
.273438	7.972762E-03
.277344	7.332347E-03
.289063	1.899486E-02
.304688	7.049414E-03
.312500	1.000841E-02
.320313	8.132186E-03
.328125	2.116899E-02
.332031	1.636854E-02
.335938	1.953609E-02
.347656	5.270335E-03
.351563	1.107219E-02
.355469	1.282552E-02
.359375	9.691418E-03
.363281	1.708809E-02
.375000	8.421800E-03
.378906	1.074906E-02
.386719	4.405667E-03
.390625	1.072598E-02
.394531	9.095707E-03
.398438	9.648572E-03
.410156	4.075690E-03
.417969	1.070166E-02
.425781	7.696448E-03
.429688	8.092252E-03
.437500	1.442797E-02
.441406	1.209565E-02
.445313	1.247091E-02
.457031	1.063512E-02
.468750	1.372637E-02
.480469	2.017188E-02
.488281	6.732498E-03
.500000	1.232534E-02

TABLE C-XIII (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE
.507813	3.671604E-03
.515625	7.699711E-03
.519531	5.087462E-03
.523438	8.769477E-03
.531250	6.346325E-03
.542969	1.629358E-02
.546875	9.721796E-03
.550781	5.317848E-03
.562500	7.795192E-03
.570313	7.084225E-03
.574219	9.724712E-03
.582031	3.217776E-03
.585938	5.991223E-03
.593750	1.262232E-02
.609375	4.041336E-03
.613281	6.261368E-03
.617188	4.136651E-03
.625000	5.750126E-03
.628906	5.646309E-03
.632813	6.965651E-03
.640625	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

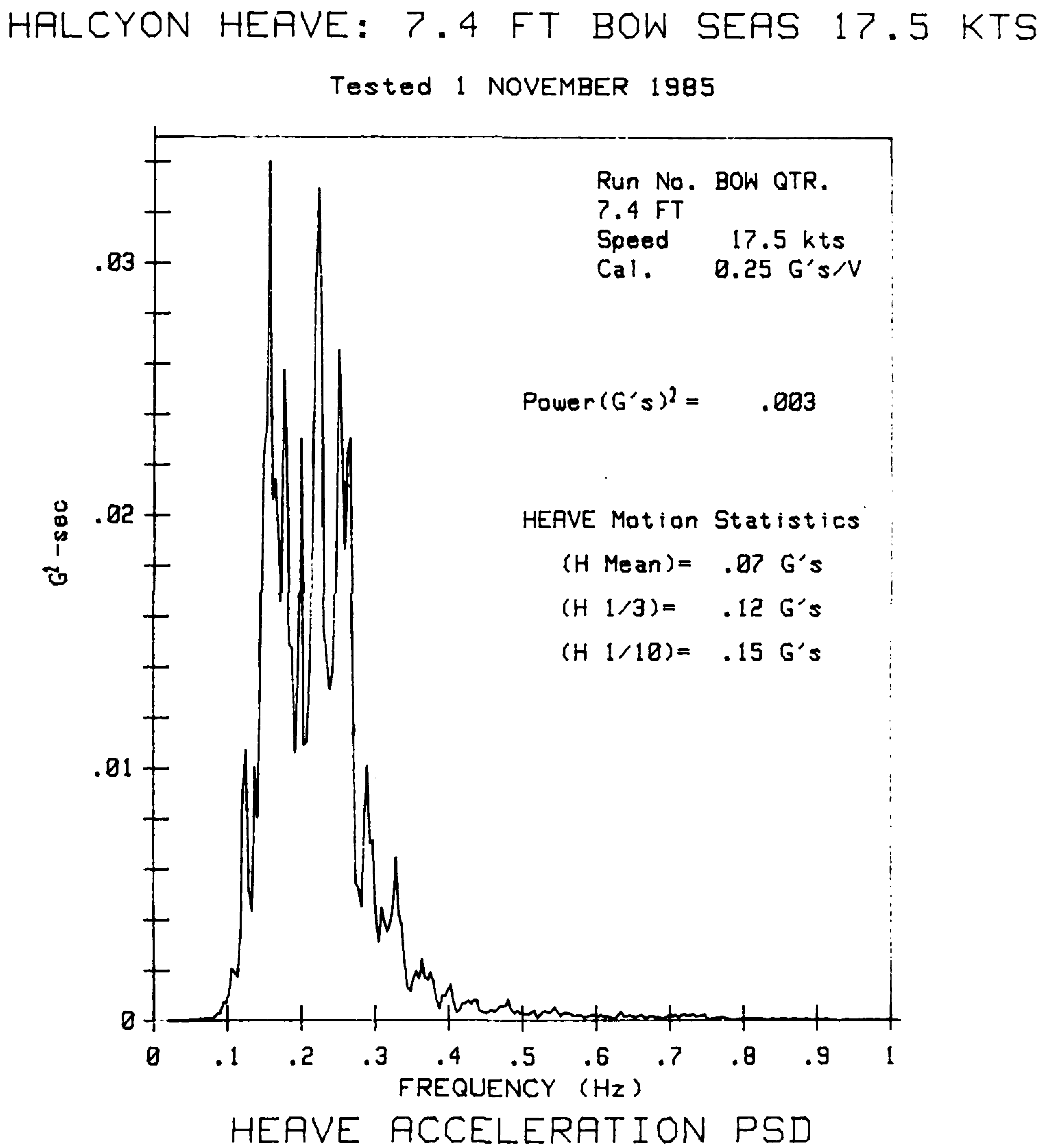


FIGURE C-14. HALCYON Heave PSD Plot, 7.4 Ft Bow Seas

TABLE C-XIV
HALCYON Heave PSD
7.4 Ft Bow Seas

HALCYON HEAVE: 7.4 FT BOW SEAS 17.5 KTS

HEAVE Energy Spectrum
Tested 1 NOVEMBER 1985

Run No. BOW QTR., Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.039063	2.028770E-06
.050781	6.643683E-05
.078125	7.101149E-05
.105469	2.066016E-03
.117188	3.295541E-03
.125000	1.073504E-02
.132813	4.344941E-03
.136719	1.006412E-02
.140625	8.047104E-03
.156250	3.403664E-02
.160156	2.060605E-02
.164063	2.140141E-02
.171875	1.655293E-02
.175781	2.575016E-02
.191406	1.057529E-02
.195313	1.395369E-02
.199219	2.300262E-02
.203125	1.089382E-02
.222656	3.294563E-02
.234375	1.438999E-02
.238281	1.311493E-02
.250000	2.652264E-02
.257813	1.863480E-02
.265625	2.300739E-02
.273438	5.416155E-03
.281250	4.513502E-03
.289063	1.008558E-02
.292969	7.005691E-03
.296875	7.097006E-03
.304688	3.116488E-03
.308594	4.476547E-03
.312500	3.904819E-03
.316406	3.534555E-03
.328125	6.473541E-03
.347656	1.184881E-03
.351563	1.695634E-03
.390625	9.856821E-04
.429688	6.783008E-04
.468750	5.647838E-04
.507813	2.546907E-04
.546875	3.520698E-04
.585938	1.558438E-04
.625000	8.827075E-05
.664063	1.436323E-04
.703125	1.848712E-04
.742188	2.162307E-04
.781250	5.173125E-05
.820313	9.698421E-05
.859375	4.265643E-05
.898438	5.306862E-05

HALCYON HEAVE: 7.4 FT BOW SEAS 17.5 KTS

Tested 1 NOVEMBER 1985

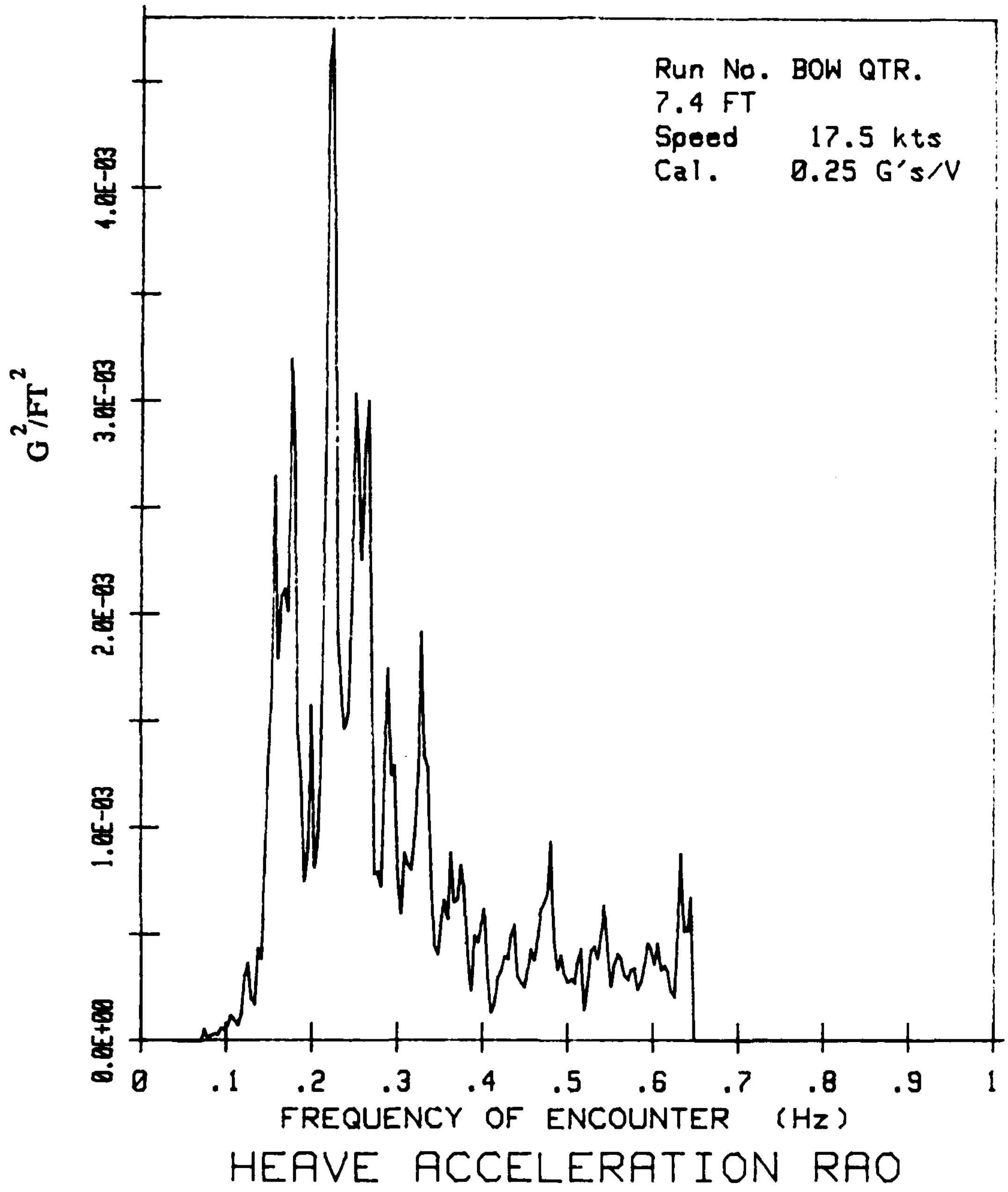


FIGURE C-15. HALCYON Heave RAO Plot, 7.4 Ft Bow Seas

TABLE C-XV
HALCYON Heave RAO
7.4 Ft Bow Seas

HALCYON HEAVE: 7.4 FT BOW SEAS 17.5 KTS

HEAVE Response Amplitude Operator
Tested 1 NOVEMBER 1985

Run No. BOW QTR., Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	G^2/FT^2
.039063	0.000000E+00
.078125	1.465737E-05
.117188	1.204549E-04
.125000	3.651181E-04
.156250	2.646478E-03
.160156	1.786536E-03
.167969	2.115922E-03
.171875	2.012870E-03
.175781	3.192953E-03
.191406	7.447160E-04
.195313	8.938432E-04
.199219	1.573810E-03
.203125	8.077930E-04
.222656	4.746291E-03
.234375	1.648363E-03
.238281	1.459368E-03
.250000	3.028709E-03
.257813	2.250654E-03
.265625	2.996490E-03
.273438	7.797367E-04
.277344	7.904618E-04
.281250	7.197462E-04
.289063	1.744539E-03
.292969	1.240902E-03
.296875	1.287366E-03
.304688	5.930238E-04
.308594	8.793126E-04
.312500	8.229135E-04
.316406	8.034416E-04
.328125	1.916139E-03
.347656	4.026851E-04
.351563	5.730773E-04
.355469	6.603165E-04
.359375	5.699978E-04
.363281	8.810939E-04
.367188	6.471906E-04
.375000	8.229276E-04
.386719	2.301714E-04
.390625	4.902693E-04
.402344	6.166241E-04
.410156	1.288994E-04
.425781	3.943038E-04
.429688	3.838484E-04
.437500	5.443477E-04
.449219	2.502299E-04
.468750	6.138579E-04
.480469	9.360644E-04
.488281	3.347741E-04
.507813	2.693444E-04
.542969	6.329019E-04

TABLE C-XV (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	G^2/FT^2
.546875	4.339274E-04
.550781	2.502346E-04
.585938	2.757014E-04
.625000	2.040930E-04
.632813	8.774923E-04
.636719	5.110363E-04
.644531	6.718487E-04
.648438	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

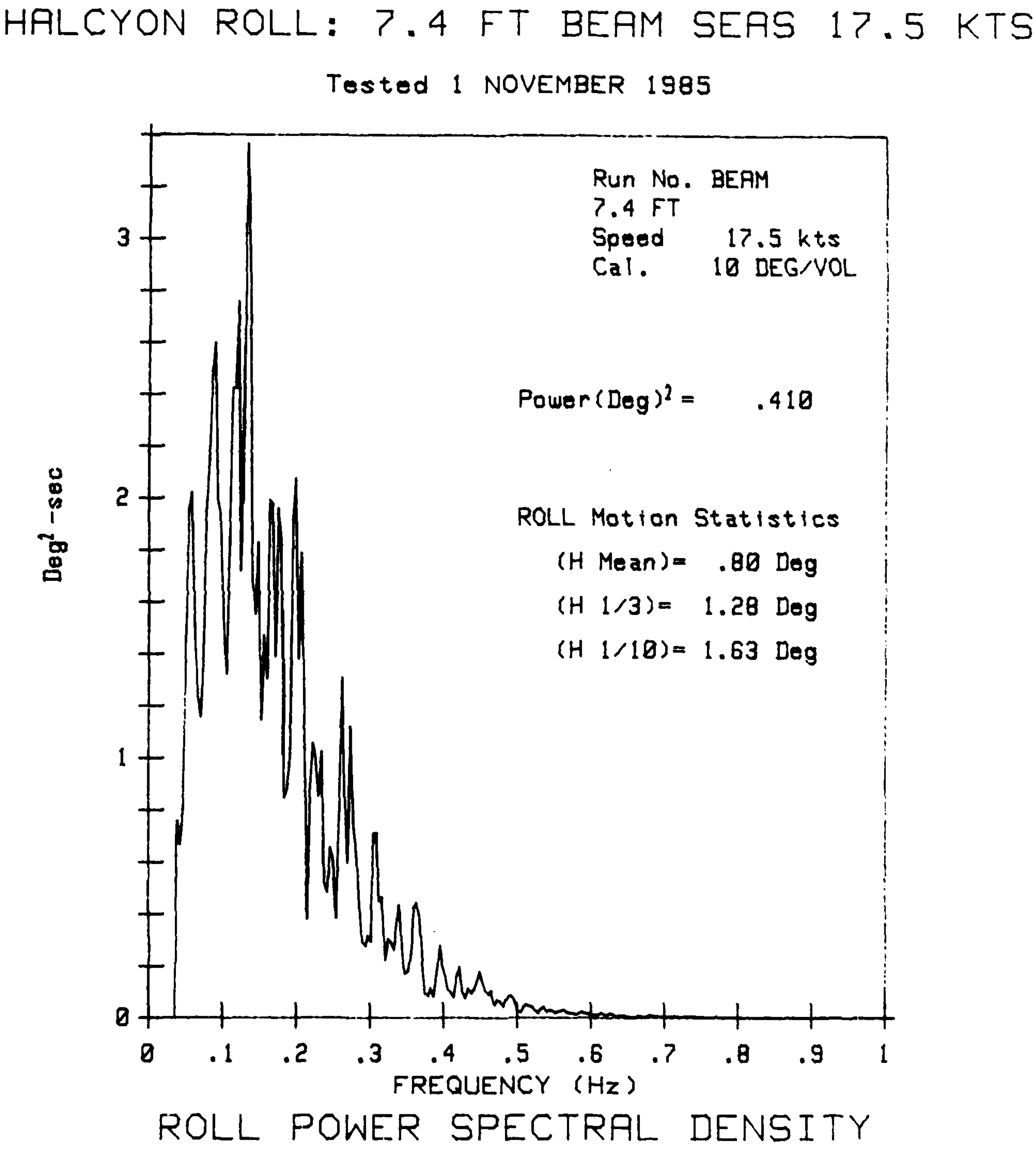


FIGURE C-16. HALCYON Roll PSD Plot, 7.4 Ft Beam Seas

TABLE C-XVI
HALCYON Roll PSD
7.4 Ft Beam Seas

HALCYON ROLL: 7.4 FT BEAM SEAS 17.5 KTS

ROLL Energy Spectrum
Tested 1 NOVEMBER 1985

Run No. BEAM, Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	7.567139E-01
.042969	6.674499E-01
.058594	2.019043E+00
.070313	1.156006E+00
.078125	1.944518E+00
.089844	2.597778E+00
.105469	1.320801E+00
.117188	2.422608E+00
.121094	2.757568E+00
.125000	1.717102E+00
.132813	3.365112E+00
.144531	1.550415E+00
.148438	1.827819E+00
.152344	1.143555E+00
.156250	1.473084E+00
.160156	1.303284E+00
.164063	1.991454E+00
.171875	1.386963E+00
.175781	1.959350E+00
.183594	8.463134E-01
.195313	1.911621E+00
.199219	2.074707E+00
.203125	1.379272E+00
.207031	1.786682E+00
.214844	3.786315E-01
.222656	1.058960E+00
.230469	8.519592E-01
.234375	1.025879E+00
.242188	4.827882E-01
.246094	6.561890E-01
.253906	3.854370E-01
.261719	1.309204E+00
.269531	5.967408E-01
.273438	1.122498E+00
.292969	2.797242E-01
.308594	7.108154E-01
.312500	4.488067E-01
.316406	4.613800E-01
.320313	2.219467E-01
.339844	4.350586E-01
.347656	1.719514E-01
.351563	1.800155E-01
.363281	4.431306E-01
.378906	8.792877E-02
.390625	1.734848E-01
.394531	2.781219E-01
.414063	7.873917E-02
.429688	7.487488E-02
.468750	5.036736E-02
.507813	4.009056E-02

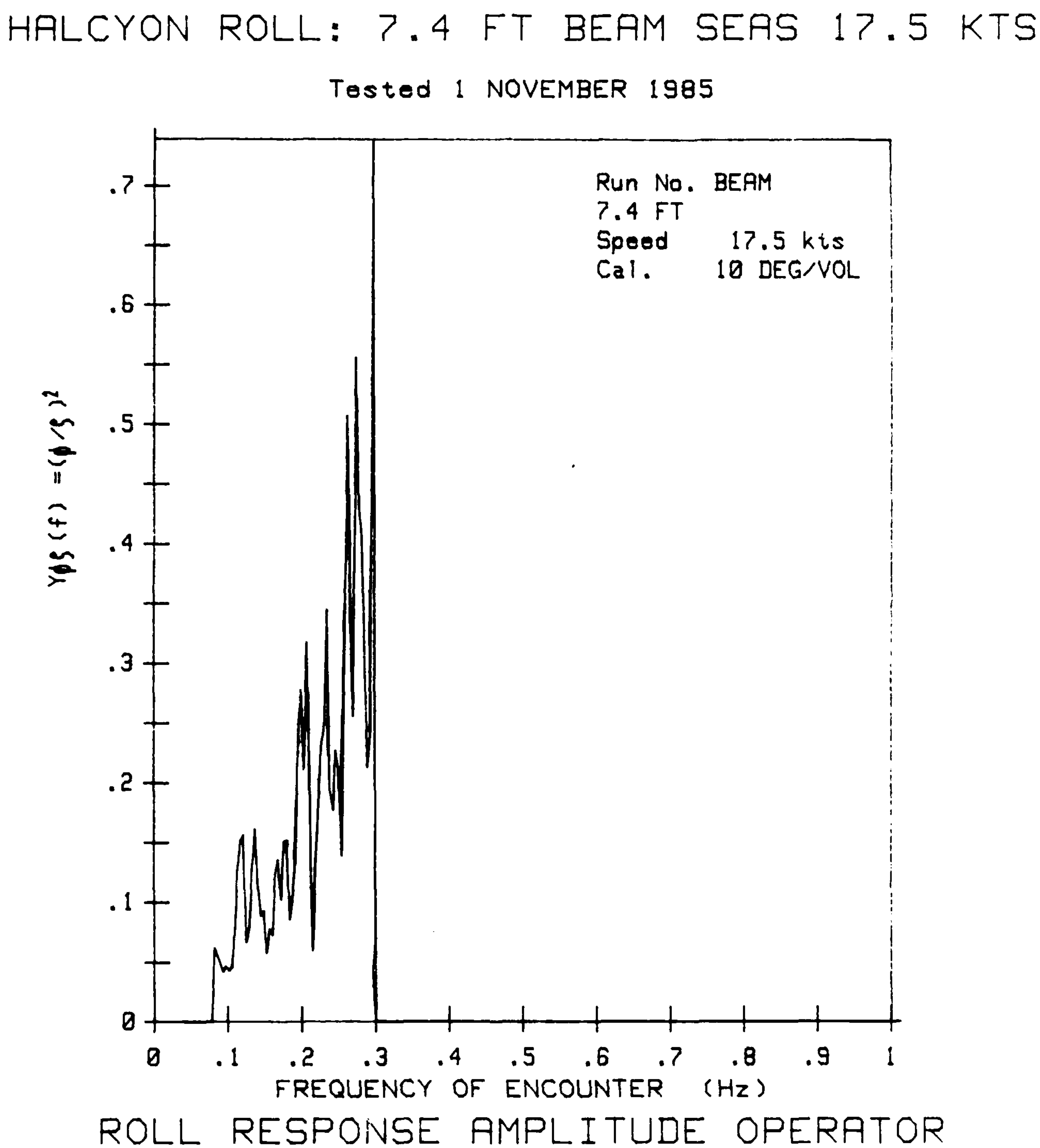


FIGURE C-17. HALCYON Roll RAO Plot, 7.4 Ft Beam Seas

TABLE C-XVII
HALCYON Roll RAO
7.4 Ft Beam Seas

HALCYON ROLL: 7.4 FT BEAM SEAS 17.5 KTS

ROLL Response Amplitude Operator
Tested 1 NOVEMBER 1985

Run No. BEAM, Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE RAO
.039063	0.000000E+00
.078125	0.000000E+00
.082031	6.218994E-02
.117188	1.516362E-01
.121094	1.557043E-01
.125000	6.591979E-02
.136719	1.613655E-01
.144531	8.852538E-02
.148438	9.199045E-02
.156250	7.711667E-02
.167969	1.353867E-01
.171875	1.019276E-01
.179688	1.517684E-01
.183594	8.518354E-02
.195313	2.493767E-01
.199219	2.780397E-01
.203125	2.112367E-01
.207031	3.174120E-01
.214844	5.921660E-02
.234375	3.448423E-01
.242188	1.771425E-01
.246094	2.266861E-01
.253906	1.386592E-01
.261719	5.067465E-01
.269531	2.552807E-01
.273438	5.551953E-01
.289063	2.129349E-01
.296875	7.388416E-01
.300781	0.000000E+00
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

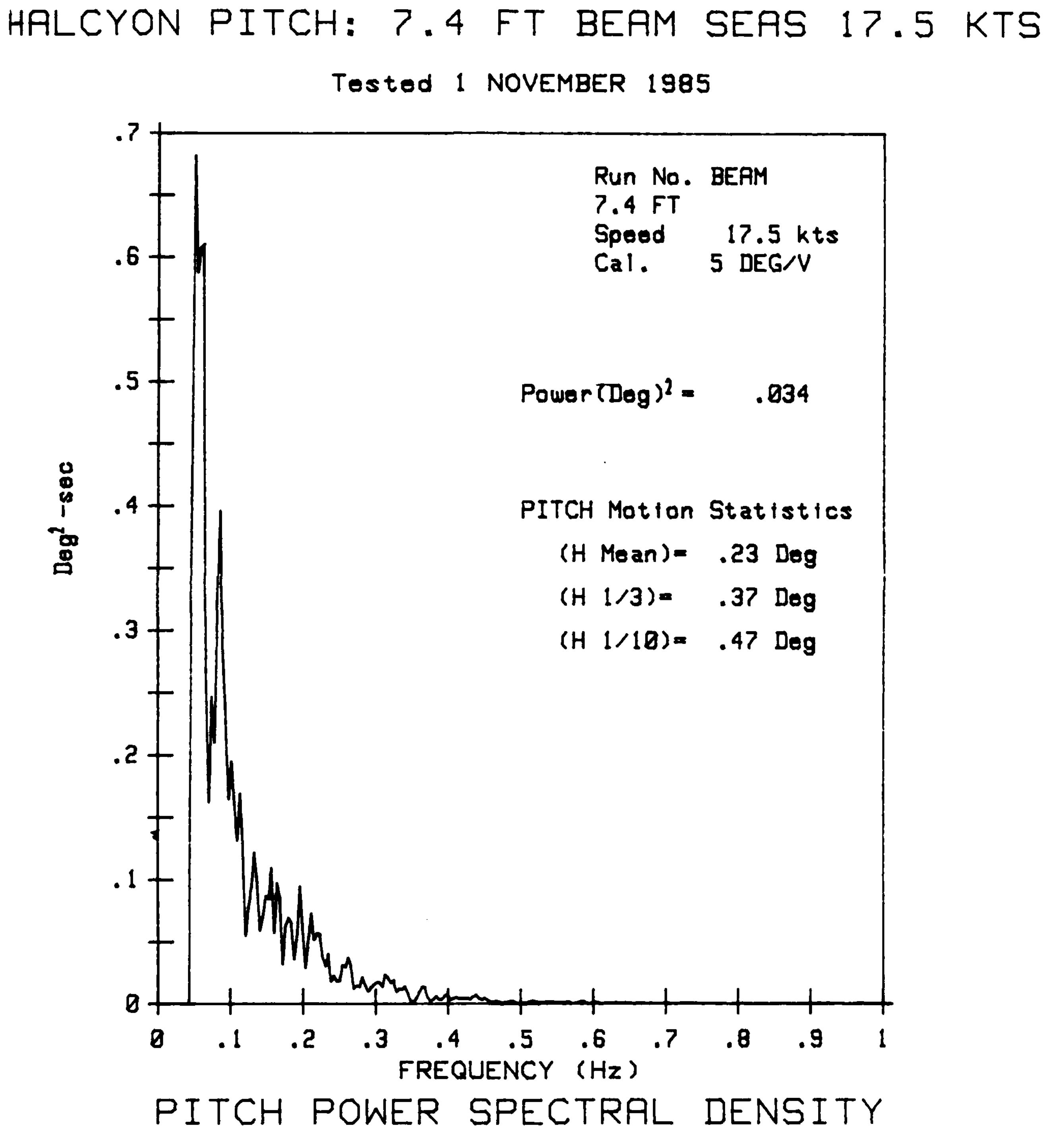


FIGURE C-18. HALCYON Pitch PSD Plot, 7.4 Ft Beam Seas

TABLE C-XVIII
HALCYON Pitch PSD
7.4 Ft Beam Seas

HALCYON PITCH: 7.4 FT BEAM SEAS 17.5 KTS

PITCH Energy Spectrum
Tested 1 NOVEMBER 1985

Run No. BEAM, Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.050781	6.820678E-01
.054688	5.871886E-01
.062500	6.098328E-01
.070313	1.617813E-01
.074219	2.466354E-01
.078125	2.098846E-01
.085938	3.957978E-01
.097656	1.641693E-01
.101563	1.949997E-01
.109375	1.307526E-01
.113281	1.690064E-01
.117188	1.290817E-01
.121094	5.468750E-02
.132813	1.216545E-01
.140625	5.909920E-02
.148438	8.628845E-02
.152344	8.465576E-02
.156250	1.091995E-01
.160156	5.718230E-02
.164063	9.700774E-02
.171875	3.190613E-02
.179688	6.925965E-02
.195313	9.441757E-02
.203125	2.905846E-02
.210938	7.235336E-02
.230469	3.039837E-02
.234375	3.995896E-02
.273438	1.447678E-02
.312500	2.373410E-02
.351563	1.568556E-03
.390625	3.677845E-03
.429688	4.004002E-03
.468750	2.156496E-03
.507813	1.391470E-03
.546875	1.455665E-03
.585938	2.310992E-03
.625000	7.203520E-04
.664063	9.714067E-04
.703125	5.181432E-04
.742188	4.556328E-04
.781250	2.213493E-04
.820313	2.621710E-04
.859375	3.069490E-04
.898438	3.792048E-04
.937500	4.365891E-04
.976563	2.811104E-04

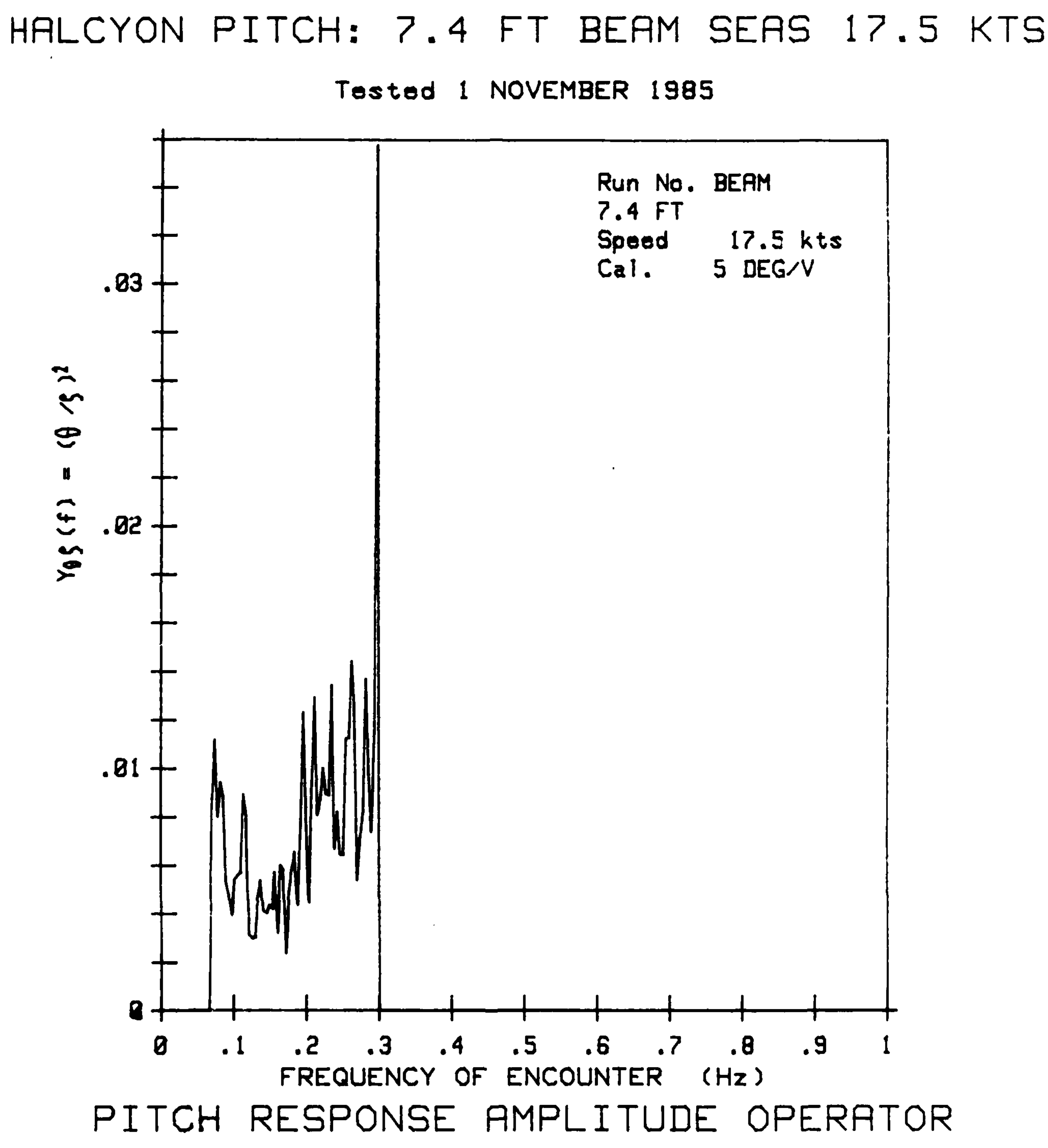


FIGURE C-19. HALCYON Pitch RAO Plot, 7.4 Ft Beam Seas

TABLE C-XIX
HALCYON Pitch RAO
7.4 Ft Beam Seas

HALCYON PITCH: 7.4 FT BEAM SEAS 17.5 KTS

PITCH Response Amplitude Operator
Tested 1 NOVEMBER 1985

Run No. BEAM, Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE RAO
.039063	0.000000E+00
.074219	1.116507E-02
.078125	7.985601E-03
.082031	9.415397E-03
.097656	3.907740E-03
.113281	8.929750E-03
.117188	8.079502E-03
.125000	2.991760E-03
.136719	5.375955E-03
.144531	4.038216E-03
.148438	4.342723E-03
.152344	4.222459E-03
.156250	5.716650E-03
.160156	3.196703E-03
.164063	6.007472E-03
.171875	2.344774E-03
.183594	6.535745E-03
.187500	4.375319E-03
.195313	1.231706E-02
.203125	4.450327E-03
.210938	1.293214E-02
.214844	8.053270E-03
.222656	1.002165E-02
.230469	8.899237E-03
.234375	1.343194E-02
.238281	6.646665E-03
.242188	8.204174E-03
.250000	6.421996E-03
.261719	1.442057E-02
.269531	5.363021E-03
.273438	7.160317E-03
.281250	1.367317E-02
.289063	7.364541E-03
.296875	3.574536E-02
.300781	0.000000E+00
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00

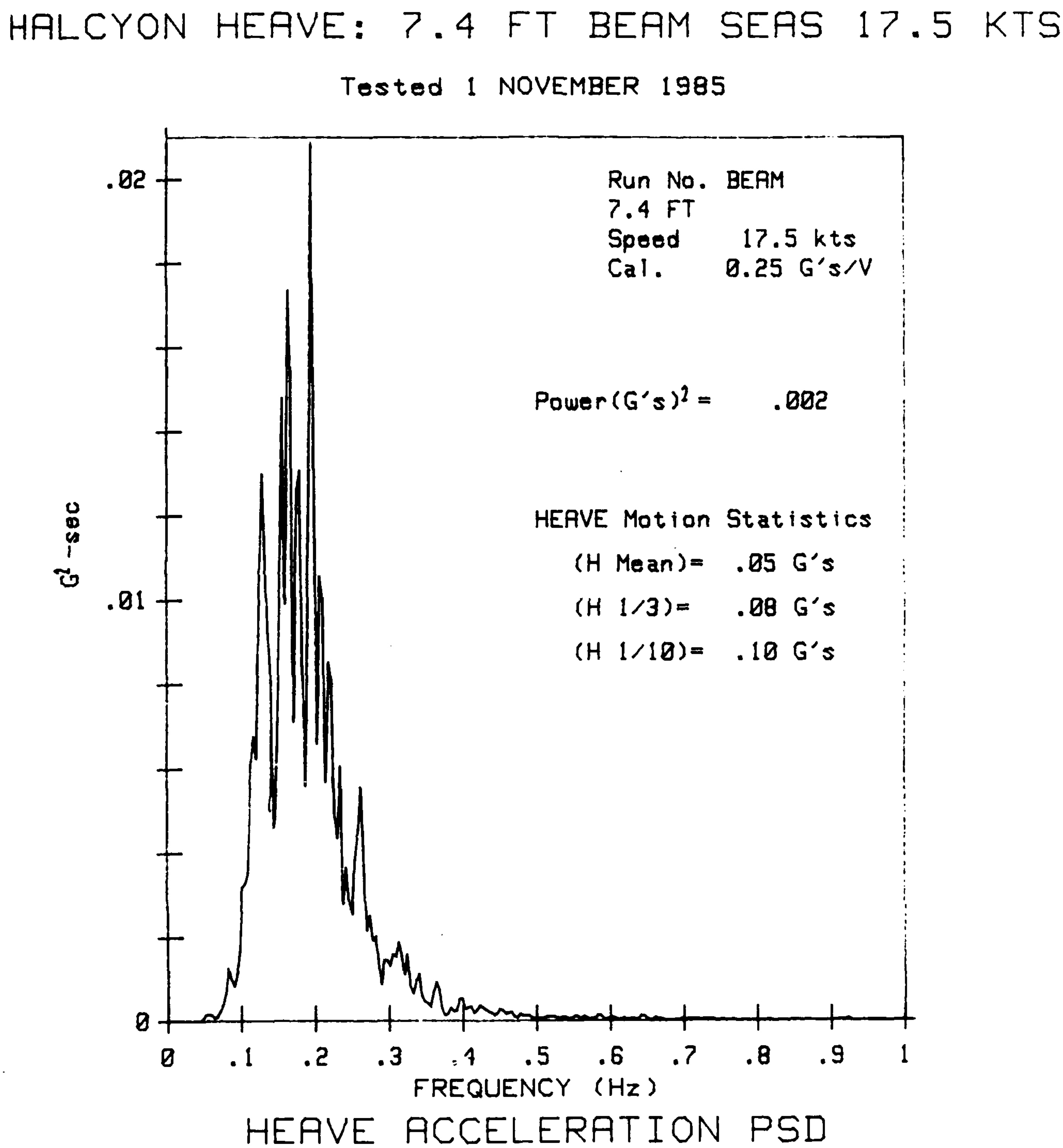


FIGURE C-20. HALCYON Heave PSD Plot, 7.4 Ft Beam Seas

TABLE C-XX
HALCYON Heave PSD
7.4 Ft Beam Seas

HALCYON HEAVE: 7.4 FT BEAM SEAS 17.5 KTS

HEAVE Energy Spectrum
Tested 1 NOVEMBER 1985

Run No. BEAM, Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.039063	1.813285E-06
.054688	1.618638E-04
.078125	6.480218E-04
.082031	1.264334E-03
.117188	6.762266E-03
.121094	6.233216E-03
.128906	1.298523E-02
.144531	4.580974E-03
.156250	1.479387E-02
.160156	9.903907E-03
.164063	1.735115E-02
.171875	7.087469E-03
.179688	1.305866E-02
.187500	5.576373E-03
.195313	2.087402E-02
.203125	6.579160E-03
.207031	1.056528E-02
.214844	5.667210E-03
.218750	8.531093E-03
.230469	4.343272E-03
.234375	6.057024E-03
.238281	2.773762E-03
.242188	3.658414E-03
.250000	2.534032E-03
.261719	5.553245E-03
.269531	2.149462E-03
.273438	2.514362E-03
.289063	8.814037E-04
.312500	1.875877E-03
.351563	4.228502E-04
.390625	2.466142E-04
.429688	2.775938E-04
.468750	1.203455E-04
.507813	5.589798E-05
.546875	6.714091E-05
.585938	1.251623E-04
.625000	5.069374E-05
.664063	5.271286E-05
.703125	4.003570E-05
.742188	2.009142E-05
.781250	3.032386E-05
.820313	1.229532E-05
.859375	1.909304E-05
.898438	2.161320E-05
.937500	1.399871E-05
.976563	1.180591E-05

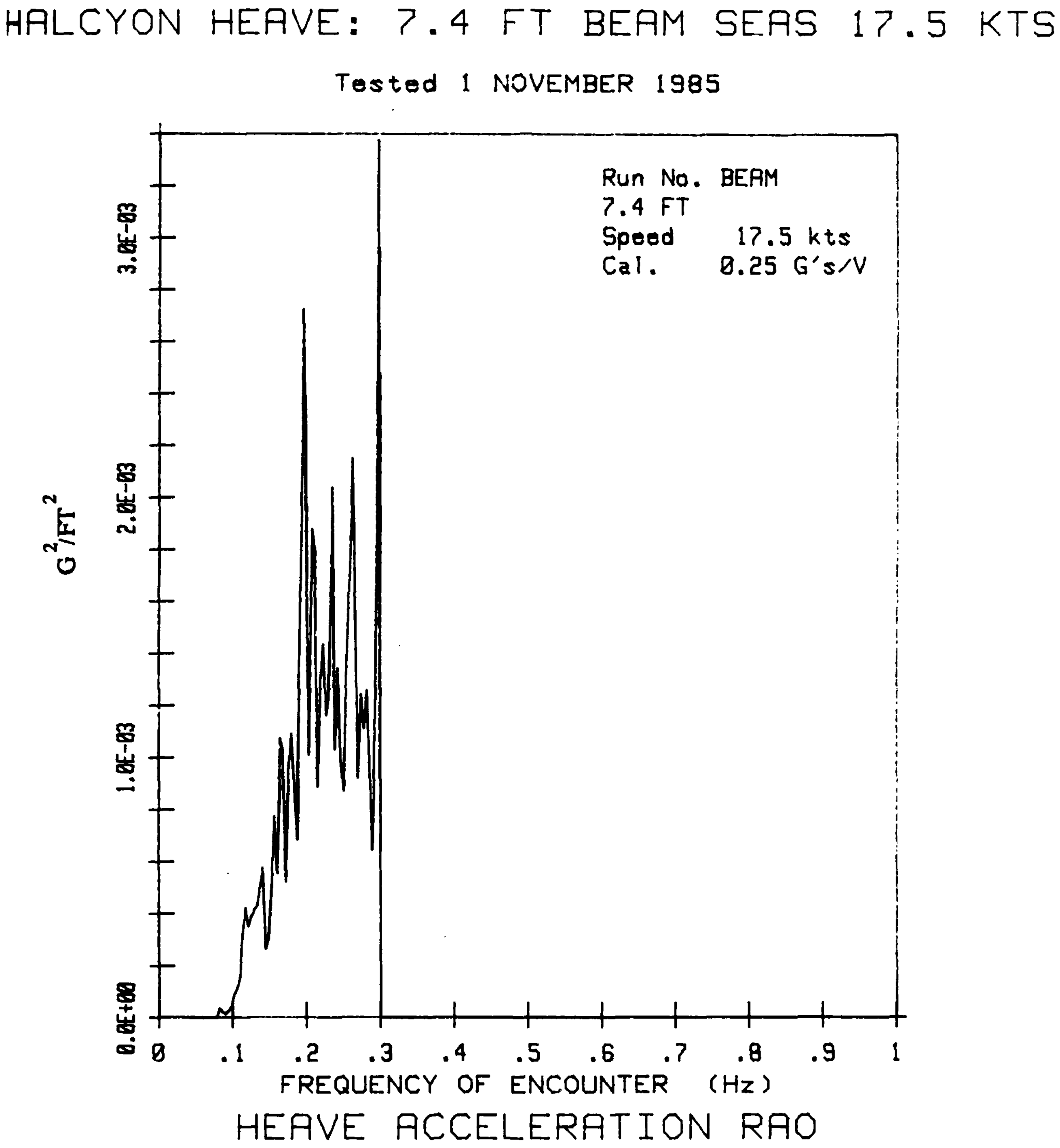


FIGURE C-21. HALCYON Heave RAO Plot, 7.4 Ft Beam Seas

TABLE C-XXI
HALCYON Heave RAO
7.4 Ft Beam Seas

HALCYON HEAVE: 7.4 FT BEAM SEAS 17.5 KTS

HEAVE Response Amplitude Operator
Tested 1 NOVEMBER 1985

Run No. BEAM, Speed 17.5 , SEAS 7.4 FT

FREQUENCY OF ENCOUNTER (HERTZ)	G^2/FT^2
.039063	0.000000E+00
.078125	0.000000E+00
.117188	4.232647E-04
.121094	3.519546E-04
.140625	5.757292E-04
.144531	2.615638E-04
.156250	7.744667E-04
.160156	5.536652E-04
.164063	1.074518E-03
.171875	5.208565E-04
.179688	1.093863E-03
.187500	6.831763E-04
.195313	2.723078E-03
.203125	1.007604E-03
.207031	1.876970E-03
.214844	8.863310E-04
.222656	1.435818E-03
.226563	1.160531E-03
.234375	2.036028E-03
.238281	1.029000E-03
.242188	1.342329E-03
.250000	8.697273E-04
.261719	2.149464E-03
.269531	9.195220E-04
.273438	1.243621E-03
.277344	1.110809E-03
.281250	1.259244E-03
.289063	6.414217E-04
.296875	3.376413E-03
.300781	0.000000E+00
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

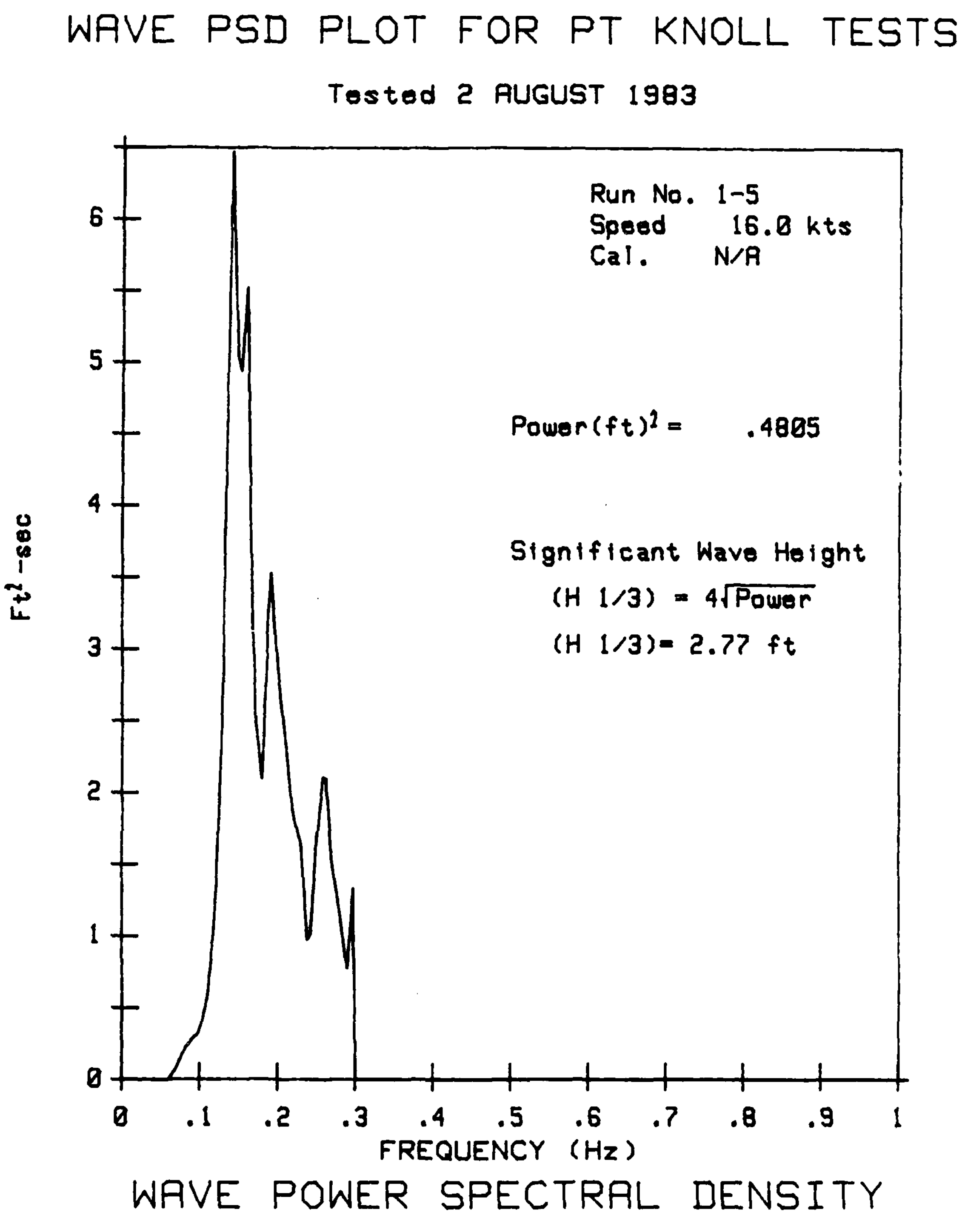


FIGURE C-22. Wave PSD Plot for PT KNOLL Seakeeping Tests, 2 August 1983

TABLE C-XXII
Wave PSD Data for PT KNOLL Seakeeping Tests
2 August 1983

WAVE PSD PLOT FOR PT KNOLL TESTS

Wave Power Spectral Density
Tested 2 AUGUST 1983

Run No. 1-5

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (FT SQR-SEC)
.039063	0.000000E+00
.078125	1.856250E-01
.117188	9.968750E-01
.140625	6.465000E+00
.152344	4.932188E+00
.156250	5.252500E+00
.160156	5.513438E+00
.179688	2.095625E+00
.191406	3.526094E+00
.195313	3.209688E+00
.234375	1.302500E+00
.238281	9.743750E-01
.257813	2.104062E+00
.273438	1.373125E+00
.289063	7.784375E-01
.296875	1.331250E+00
.300781	0.000000E+00
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

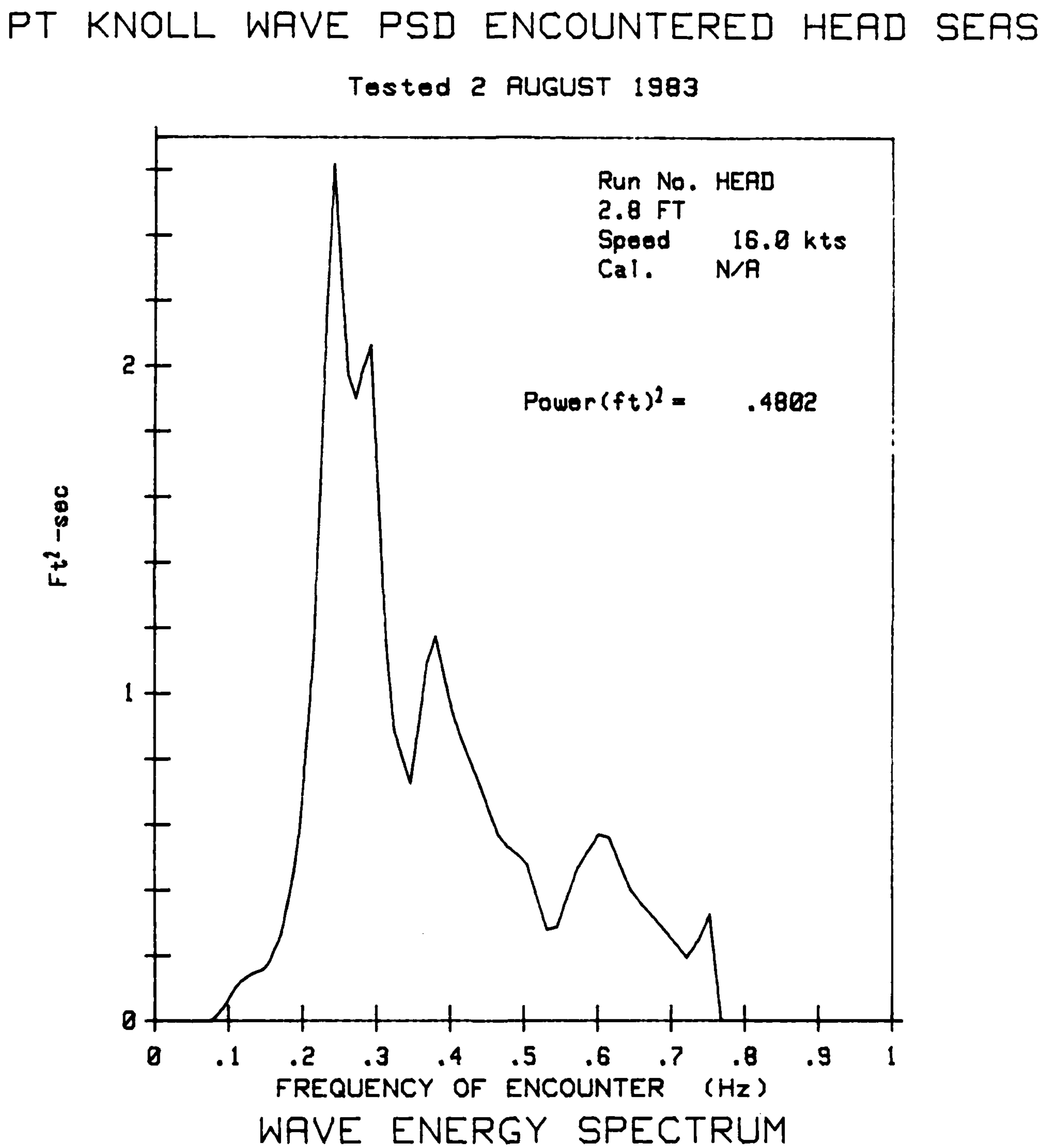


FIGURE C- 23. PT KNOLL Wave PSD Encountered Plot, 2.8 Ft Head Seas

TABLE C-XXIII
PT KNOLL Wave PSD Encountered
2.8 Ft Head Seas

PT KNOLL WAVE PSD ENCOUNTERED HEAD SEAS

Wave Energy Spectrum
Tested 2 AUGUST 1983

Run No. HEAD, Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (FT SQR-SEC)
.046682	0.000000E+00
.109207	1.021292E-01
.187577	4.477667E-01
.242204	2.615723E+00
.271657	1.901218E+00
.281791	1.993281E+00
.292084	2.060343E+00
.345924	7.275547E-01
.380130	1.174190E+00
.391849	1.054473E+00
.517750	3.772461E-01
.531212	2.789084E-01
.600897	5.689856E-01
.659496	3.556002E-01
.720631	1.934035E-01
.752149	3.241658E-01
.768145	0.000000E+00
.817086	0.000000E+00
.990520	0.000000E+00
1.179798	0.000000E+00
1.384919	0.000000E+00
1.605885	0.000000E+00
1.842695	0.000000E+00
2.095349	0.000000E+00
2.363847	0.000000E+00
2.648189	0.000000E+00
2.948375	0.000000E+00
3.264405	0.000000E+00
3.596279	0.000000E+00
3.943997	0.000000E+00
4.307559	0.000000E+00
4.686965	0.000000E+00
5.082215	0.000000E+00
5.493309	0.000000E+00
5.920247	0.000000E+00

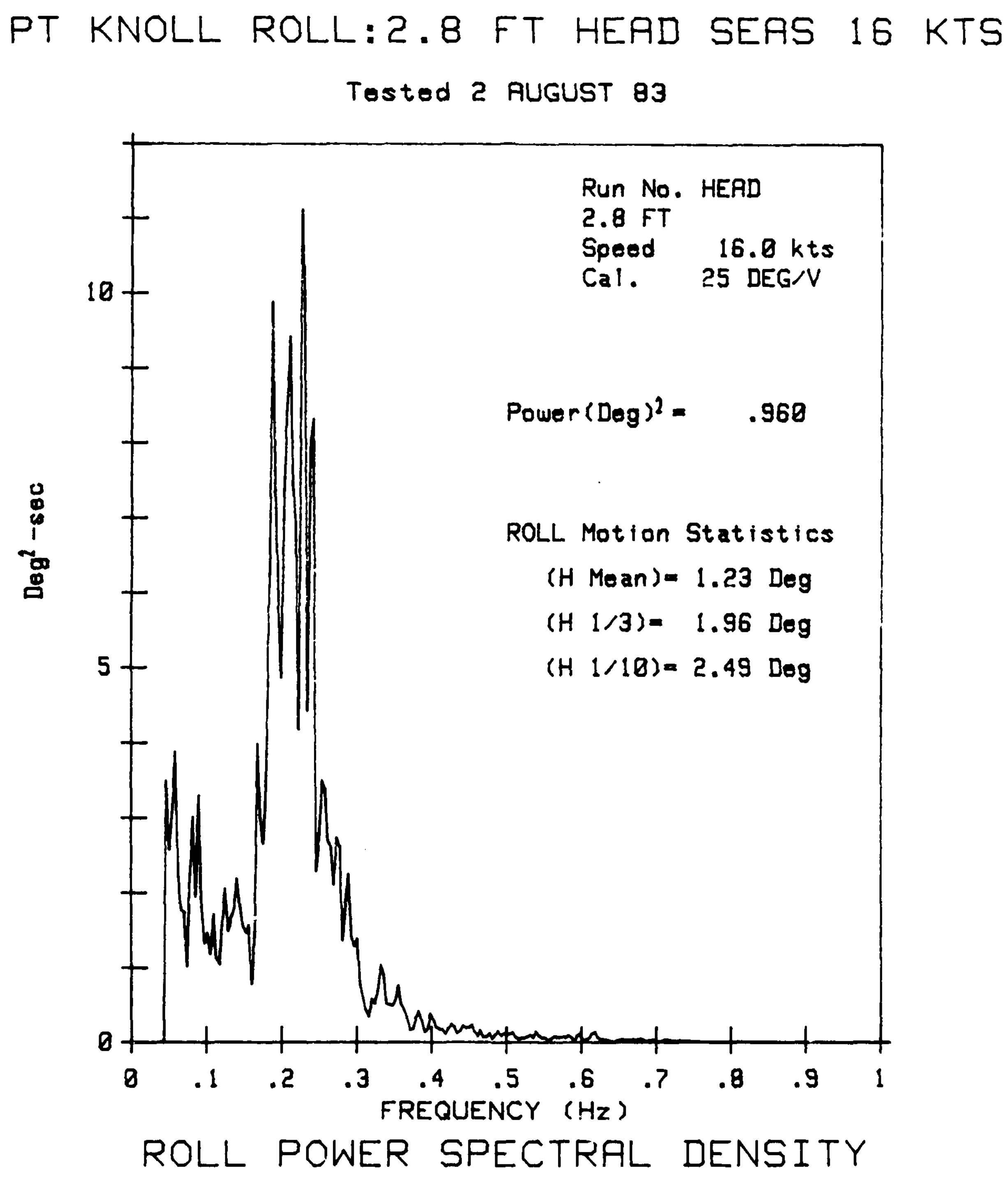


FIGURE C-24. PT KNOLL Roll PSD Plot, 2.8 Ft Head Seas

TABLE C-XXIV
PT KNOLL Roll PSD
2.8 Ft Head Seas

PT KNOLL ROLL:2.8 FT HEAD SEAS 16 KTS

ROLL Energy Spectrum
Tested 2 AUGUST 83

Run No. 16, Speed 16 , SEAS

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.046875	3.490966E+00
.050781	2.569214E+00
.058594	3.880616E+00
.074219	1.013428E+00
.078125	2.242675E+00
.082031	3.013427E+00
.085938	1.942688E+00
.089844	3.298950E+00
.097656	1.315308E+00
.101563	1.461853E+00
.109375	1.718139E+00
.117188	1.042908E+00
.125000	2.053834E+00
.128906	1.481567E+00
.140625	2.183350E+00
.152344	1.463501E+00
.156250	1.559021E+00
.160156	7.731323E-01
.167969	3.983398E+00
.175781	2.656006E+00
.187500	9.870117E+00
.195313	5.938232E+00
.199219	4.855957E+00
.210938	9.408691E+00
.222656	4.164550E+00
.226563	1.111475E+01
.234375	4.415528E+00
.242188	8.305176E+00
.246094	2.275147E+00
.253906	3.500610E+00
.269531	2.094483E+00
.273438	2.731933E+00
.281250	1.350952E+00
.289063	2.244141E+00
.296875	1.280090E+00
.300781	1.379944E+00
.312500	4.263611E-01
.316406	3.473816E-01
.332031	1.033569E+00
.351563	5.553589E-01
.371094	1.617278E-01
.390625	1.312790E-01
.429688	2.076797E-01
.468750	7.347488E-02
.507813	1.292038E-01
.546875	6.049918E-02
.585938	6.678390E-02
.625000	4.071998E-02
.664063	2.468299E-02

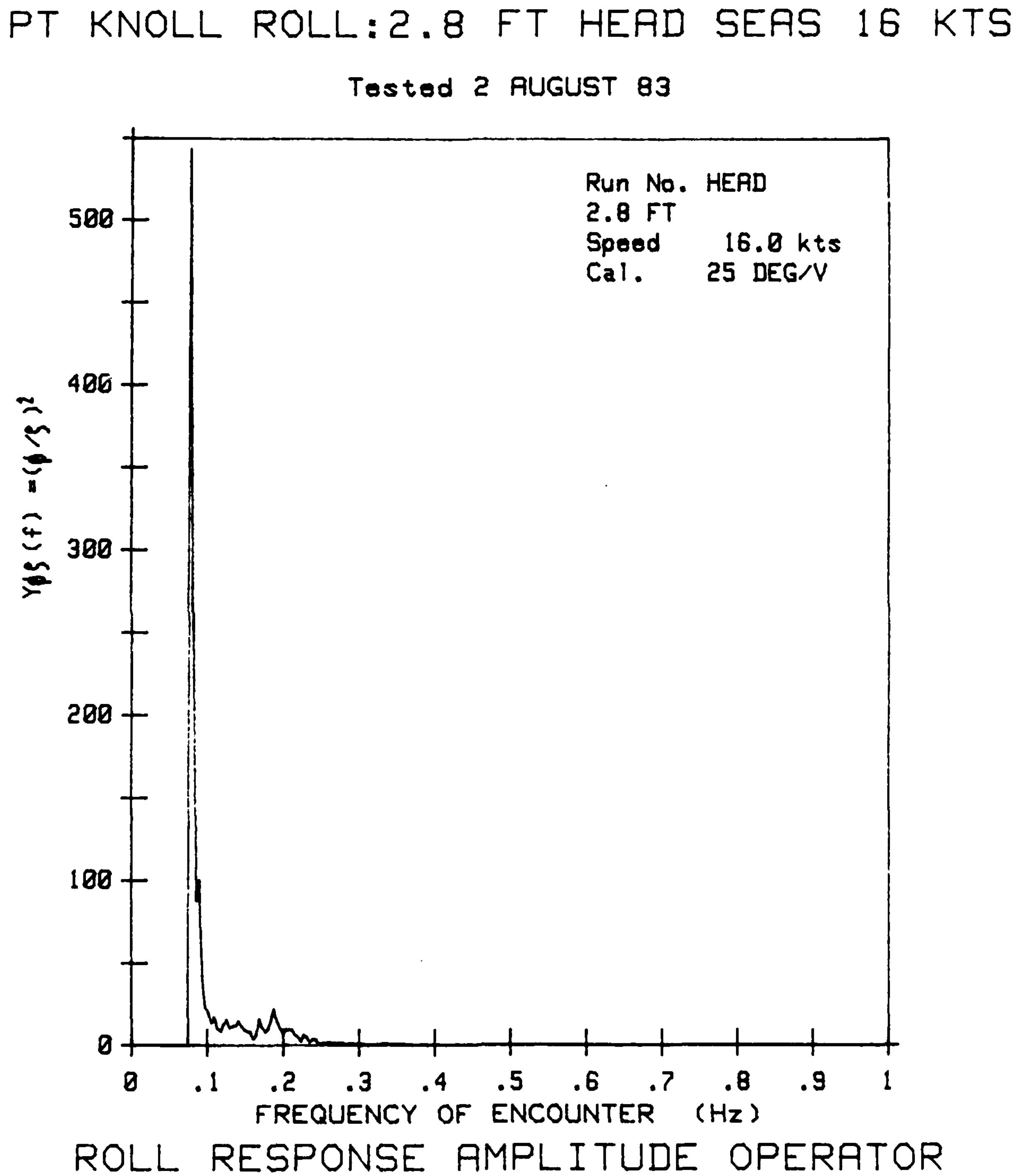


FIGURE C-25. PT KNOLL Roll RAO Plot, 2.8 Ft Head Seas

TABLE C-XXV
PT KNOLL Roll RAO
2.8 Ft Head Seas

PT KNOLL ROLL:2.8 FT HEAD SEAS 16 KTS

ROLL Response Amplitude Operator
Tested 2 AUGUST 83

Run No. HEAD, Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE RAO
.039063	0.000000E+00
.078125	5.434564E+02
.085938	8.722087E+01
.089844	9.957191E+01
.105469	1.339110E+01
.117188	8.545845E+00
.156250	8.242932E+00
.195313	1.036216E+01
.234375	1.948585E+00
.273438	1.424813E+00
.312500	3.606710E-01
.351563	6.805820E-01
.390625	1.230387E-01
.429688	2.664065E-01
.468750	1.314913E-01
.507813	2.855535E-01
.546875	2.006577E-01
.585938	1.293854E-01
.625000	8.047329E-02
.664063	7.172357E-02
.703125	2.633142E-02
.742188	5.708493E-02
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

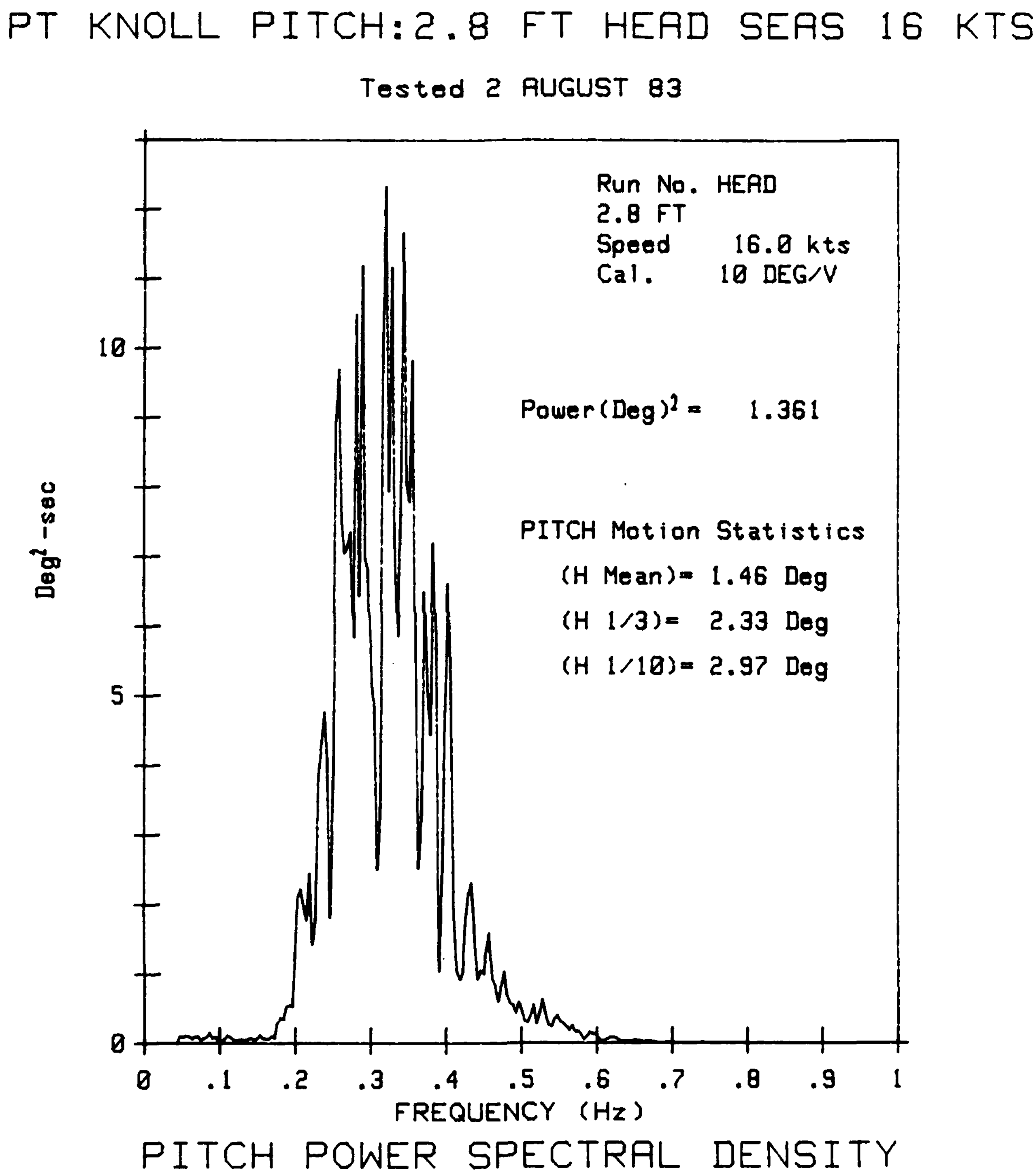


FIGURE C-26. PT KNOLL Pitch PSD Plot, 2.8 Ft Head Seas

TABLE C-XXVI
PT KNOLL Pitch PSD
2.8 Ft Head Seas

PT KNOLL PITCH: 2.8 FT HEAD SEAS 16 KNOTS

PITCH Energy Spectrum
Tested 2 AUGUST 1983

Run No. HEAD, Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	1.753082E-01
.042969	2.251358E-01
.078125	6.976699E-02
.117188	5.868339E-02
.156250	7.666779E-02
.195313	5.359192E-01
.207031	2.215088E+00
.214844	1.767638E+00
.218750	2.446899E+00
.222656	1.415100E+00
.234375	4.330078E+00
.238281	4.768066E+00
.246094	1.801696E+00
.257813	9.684570E+00
.265625	7.034424E+00
.273438	7.341309E+00
.277344	5.831054E+00
.281250	1.047949E+01
.285156	6.423096E+00
.289063	1.117578E+01
.308594	2.485840E+00
.312500	3.396362E+00
.320313	1.232764E+01
.324219	7.923584E+00
.328125	1.115430E+01
.335938	5.853027E+00
.343750	1.165625E+01
.351563	7.775147E+00
.355469	9.809082E+00
.363281	2.511352E+00
.371094	6.493165E+00
.378906	4.426758E+00
.382813	7.193848E+00
.390625	1.030334E+00
.402344	6.608398E+00
.417969	9.145203E-01
.429688	2.154053E+00
.433594	2.314574E+00
.441406	9.209595E-01
.457031	1.583984E+00
.468750	5.931091E-01
.507813	2.984925E-01
.546875	3.892670E-01
.585938	9.604645E-02
.625000	6.871032E-02
.664063	2.172374E-02
.703125	5.048514E-03
.742188	6.756067E-03
.781250	4.500150E-03
.820313	4.748821E-03

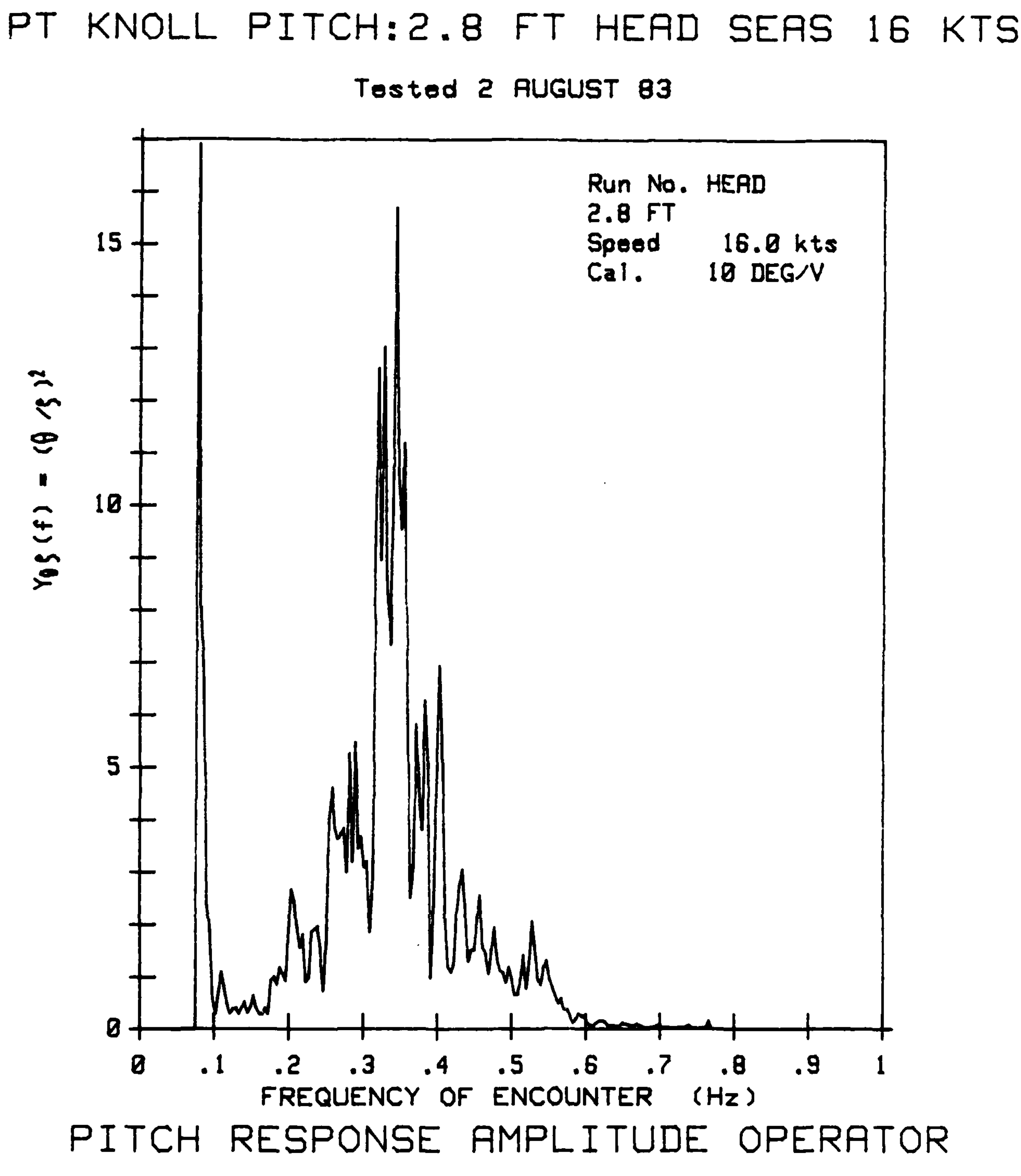


FIGURE C-27. PT KNOLL Pitch RAO Plot, 2.8 Ft Head Seas

TABLE C-XXVII
PT KNOLL PITCH RAO
2.8 Ft Head Seas

PT KNOLL PITCH:2.8 FT HEAD SEAS 16 KTS

PITCH Response Amplitude Operator
Tested 2 AUGUST 83

Run No. HEAD, Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE RAO
.039063	0.000000E+00
.078125	1.690629E+01
.101563	2.929382E-01
.117188	4.808663E-01
.156250	4.053617E-01
.187500	1.184424E+00
.195313	9.351736E-01
.203125	2.672018E+00
.214844	1.554595E+00
.218750	1.810641E+00
.222656	9.037798E-01
.234375	1.910876E+00
.238281	1.953725E+00
.246094	7.255001E-01
.257813	4.624208E+00
.265625	3.621903E+00
.273438	3.828789E+00
.277344	2.985871E+00
.281250	5.270400E+00
.285156	3.187311E+00
.289063	5.476554E+00
.292969	3.443082E+00
.296875	3.672194E+00
.300781	3.083077E+00
.304688	3.194102E+00
.308594	1.846450E+00
.312500	2.873079E+00
.320313	1.261086E+01
.324219	8.942070E+00
.328125	1.301644E+01
.335938	7.325803E+00
.343750	1.568596E+01
.351563	9.528298E+00
.355469	1.118117E+01
.363281	2.492519E+00
.371094	5.828694E+00
.378906	3.796405E+00
.382813	6.273058E+00
.390625	9.656606E-01
.402344	6.945313E+00
.417969	1.081089E+00
.429688	2.763167E+00
.433594	3.055767E+00
.441406	1.292164E+00
.457031	2.561976E+00
.468750	1.061433E+00
.476563	1.941016E+00
.492188	8.730804E-01
.507813	6.596986E-01
.527344	2.057978E+00

TABLE C-XXVII (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE
.539063	8.426635E-01
.546875	1.291082E+00
.585938	1.860779E-01
.625000	1.357895E-01
.664063	6.312462E-02
.703125	2.093523E-02
.742188	2.463474E-02
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

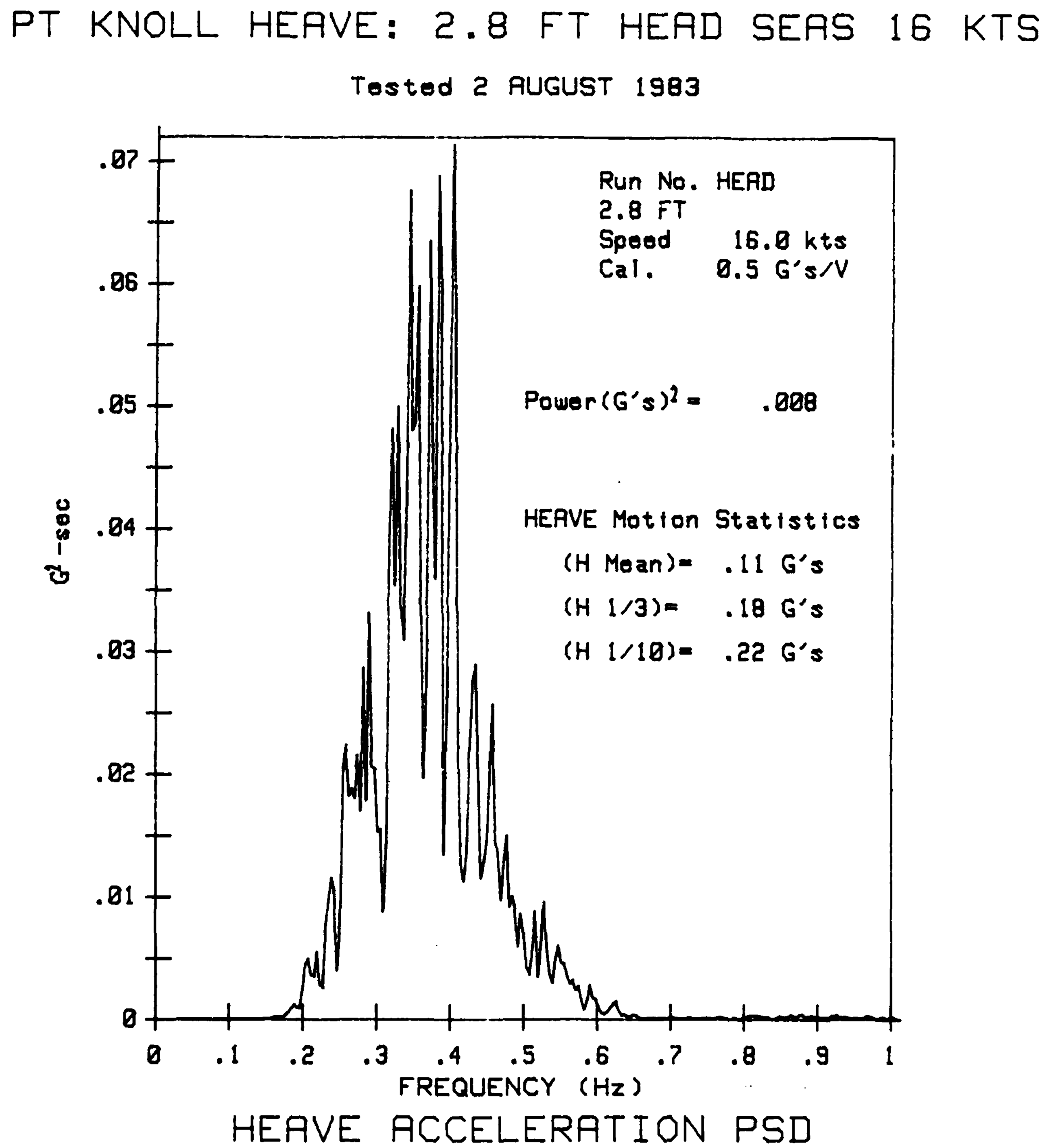


FIGURE C-28. PT KNOLL Heave PSD Plot, 2.8 Ft Head Seas

TABLE C-XXVIII
PT KNOLL Heave PSD
2.8 Ft Head Seas

PT KNOLL HEAVE: 2.8 FT HEAD SEAS 16 KTS

HEAVE Energy Spectrum
Tested 2 AUGUST 1983

Run No. HEAD, Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.039063	2.111046E-07
.042969	2.608139E-07
.078125	5.322509E-07
.117188	2.305582E-05
.156250	1.139753E-04
.195313	1.003921E-03
.207031	4.963398E-03
.234375	9.806157E-03
.238281	1.151705E-02
.246094	4.003763E-03
.257813	2.239514E-02
.261719	1.823902E-02
.265625	1.882744E-02
.269531	1.803875E-02
.273438	2.159024E-02
.277344	1.705646E-02
.281250	2.867984E-02
.285156	1.786422E-02
.289063	3.314018E-02
.300781	1.530313E-02
.304688	1.546383E-02
.308594	8.779050E-03
.312500	1.423550E-02
.320313	4.815293E-02
.324219	3.534507E-02
.328125	4.992675E-02
.335938	3.092290E-02
.343750	6.763077E-02
.347656	4.799080E-02
.351563	4.867934E-02
.355469	5.975533E-02
.363281	1.966954E-02
.371094	6.347656E-02
.378906	3.594589E-02
.382813	6.884003E-02
.390625	1.348162E-02
.402344	7.133866E-02
.417969	1.129961E-02
.429688	2.769757E-02
.433594	2.900506E-02
.441406	1.151705E-02
.457031	2.574920E-02
.468750	9.773254E-03
.476563	1.502323E-02
.480469	9.195805E-03
.484375	1.009035E-02
.492188	5.938053E-03
.496094	8.650779E-03
.507813	3.670454E-03
.515625	8.883477E-03

TABLE C-XXVIII (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.519531	3.463149E-03
.527344	9.591579E-03
.539063	3.002643E-03
.546875	6.017208E-03
.585938	1.567483E-03
.625000	1.478255E-03
.664063	9.918213E-05
.703125	1.444668E-04
.742188	9.386614E-05
.781250	6.549434E-05
.820313	2.620965E-04
.859375	2.237782E-04
.898438	1.806766E-04
.937500	2.337546E-04
.976563	8.499622E-05

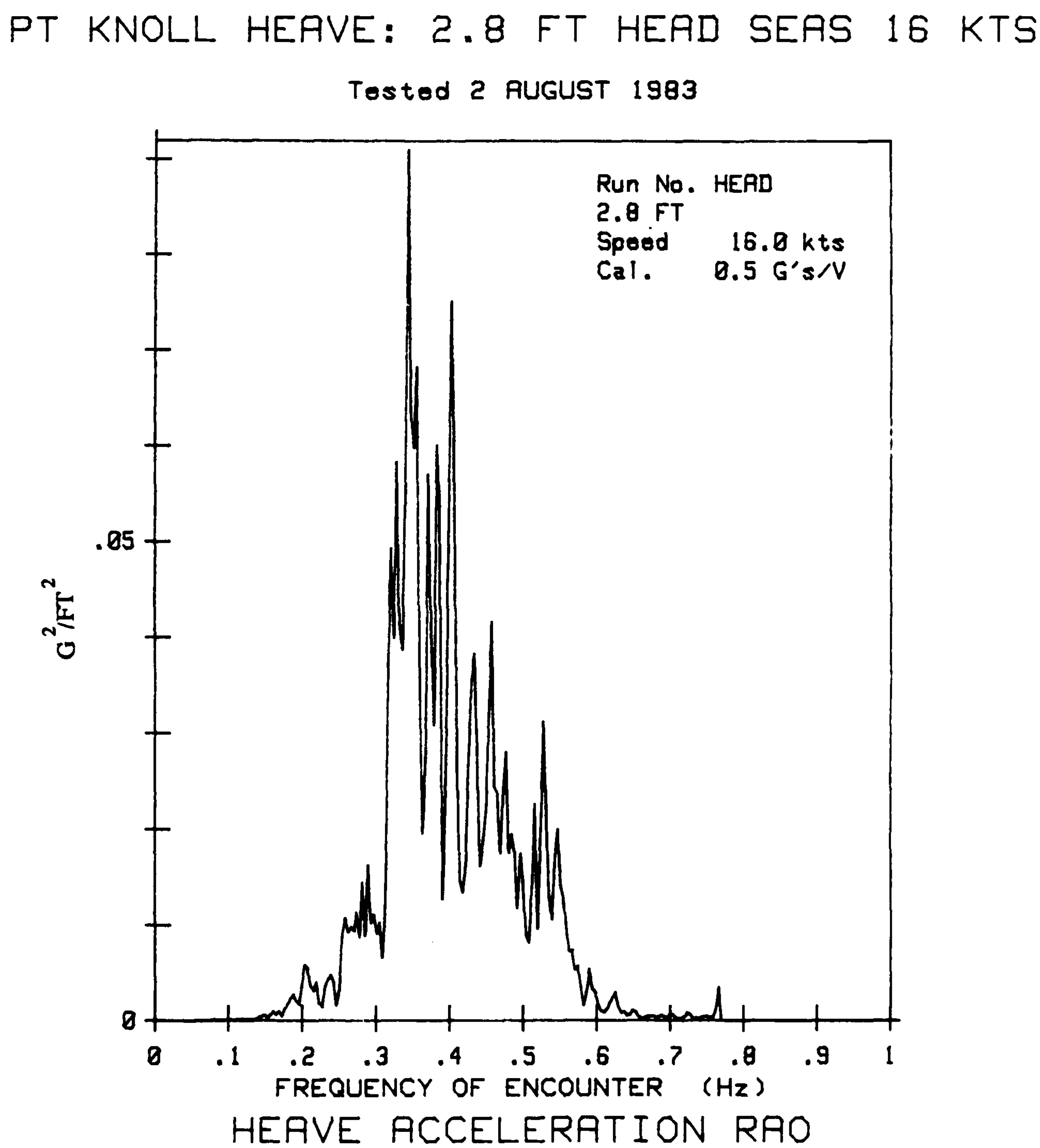


FIGURE C-29. PT KNOLL Heave RAO Plot, 2.8 Ft Head Seas

TABLE C-XXIX
PT KNOLL Heave RAO
2.8 Ft Head Seas

PT KNOLL HEAVE: 2.8 FT HEAD SEAS 16 KTS

HEAVE Response Amplitude Operator
Tested 2 AUGUST 1983

Run No. HEAD, Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	G^2/FT^2
.039063	0.000000E+00
.078125	1.289777E-04
.117188	1.889252E-04
.156250	6.026156E-04
.195313	1.751832E-03
.203125	5.793952E-03
.234375	4.327484E-03
.257813	1.069328E-02
.261719	9.264384E-03
.265625	9.693923E-03
.269531	9.416492E-03
.273438	1.126018E-02
.281250	1.442381E-02
.285156	8.864704E-03
.289063	1.623994E-02
.292969	1.019755E-02
.296875	1.105252E-02
.304688	1.023804E-02
.312500	1.204221E-02
.320313	4.925922E-02
.324219	3.988828E-02
.328125	5.826173E-02
.335938	3.870391E-02
.343750	9.101158E-02
.351563	5.965563E-02
.355469	6.811386E-02
.363281	1.952203E-02
.371094	5.698076E-02
.378906	3.082733E-02
.382813	6.002872E-02
.390625	1.263538E-02
.402344	7.497569E-02
.417969	1.335770E-02
.429688	3.552977E-02
.433594	3.829330E-02
.441406	1.615914E-02
.457031	4.164740E-02
.468750	1.749030E-02
.476563	2.805914E-02
.480469	1.746244E-02
.484375	1.939931E-02
.492188	1.172128E-02
.496094	1.738950E-02
.507813	8.112076E-03
.515625	2.258509E-02
.519531	9.507958E-03
.527344	3.122603E-02
.539063	1.056585E-02
.546875	1.995728E-02
.562500	7.223296E-03

TABLE C-XXIX (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	G^2/FT^2
.582031	1.571517E-03
.585938	3.036801E-03
.625000	2.921416E-03
.664063	2.882023E-04
.703125	5.990762E-04
.742188	3.422654E-04
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

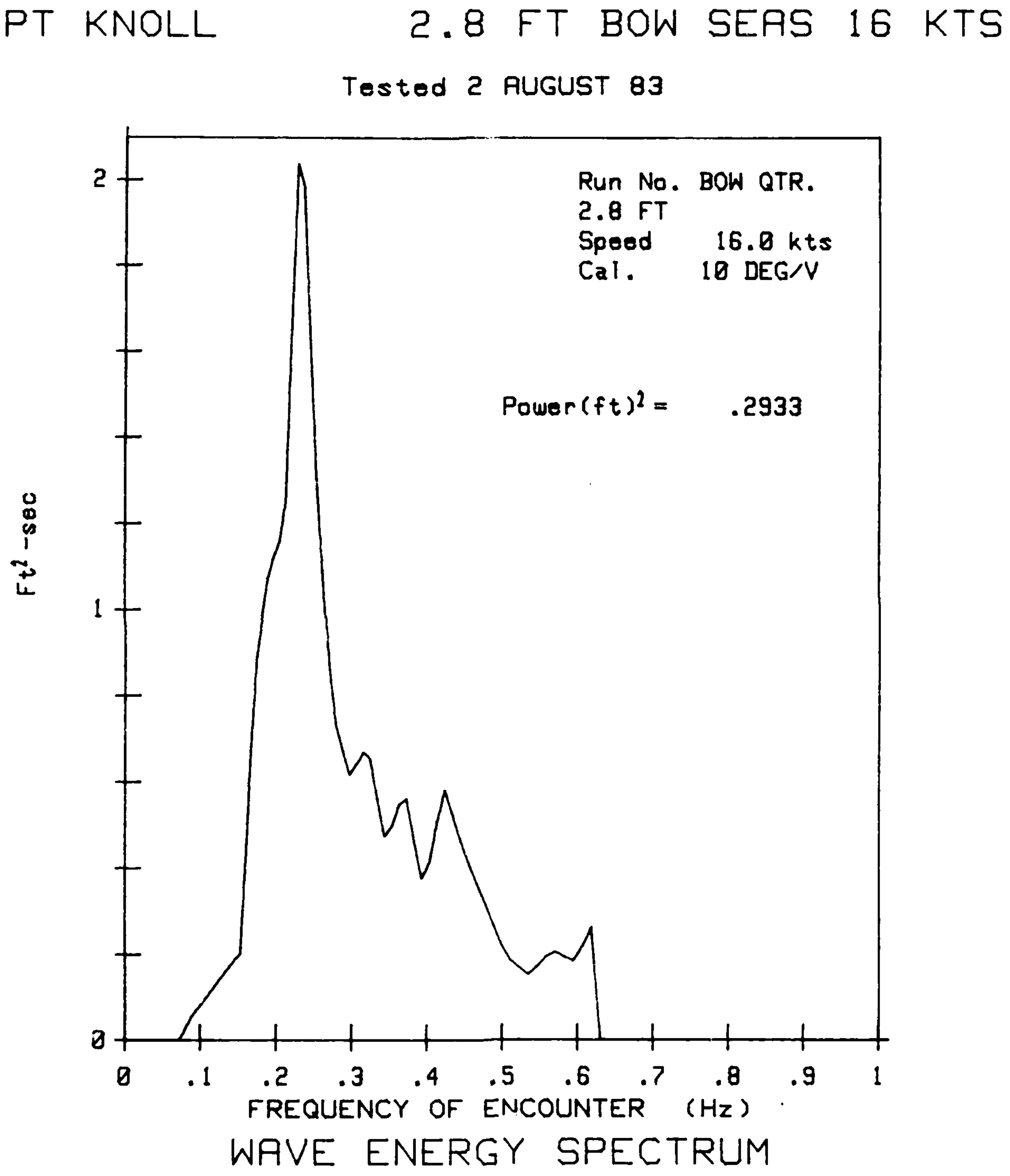


FIGURE C-30. PT KNOLL Wave PSD Encountered Plot,
2.8 Ft Bow Seas

TABLE C-XXX
PT KNOLL Pitch PSD Encountered
2.8 Ft Bow Seas

PT KNOLL PITCH:2.8 FT BOW SEAS 16 KTS

Wave Energy Spectrum
Tested 2 AUGUST 83

Run No. BOW QTR., Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (FT SQR-SEC)
.044361	0.000000E+00
.099926	8.158566E-02
.166694	6.831959E-01
.228175	2.037135E+00
.244666	1.641204E+00
.296827	6.175898E-01
.315110	6.680823E-01
.333841	5.618058E-01
.343375	4.731433E-01
.372648	5.606029E-01
.392724	3.751906E-01
.423678	5.811330E-01
.434220	5.207023E-01
.534139	1.520009E-01
.545801	1.704450E-01
.618128	2.621791E-01
.630575	0.000000E+00
.668587	0.000000E+00
.802575	0.000000E+00
.947767	0.000000E+00
1.104163	0.000000E+00
1.271762	0.000000E+00
1.450564	0.000000E+00
1.640570	0.000000E+00
1.841779	0.000000E+00
2.054192	0.000000E+00
2.277807	0.000000E+00
2.512627	0.000000E+00
2.758650	0.000000E+00
3.015876	0.000000E+00
3.284305	0.000000E+00
3.563938	0.000000E+00
3.854775	0.000000E+00
4.156815	0.000000E+00
4.470058	0.000000E+00

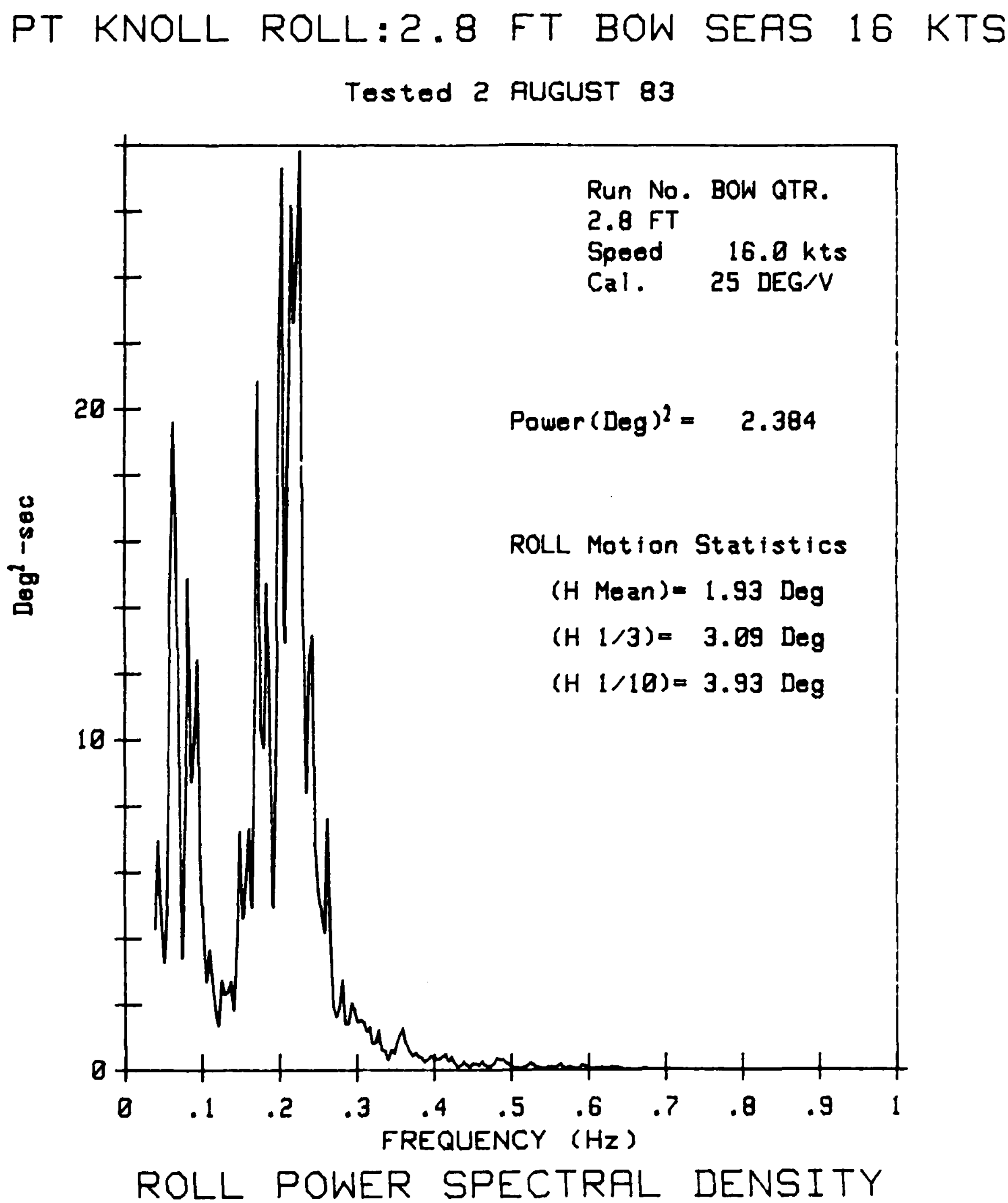


FIGURE C-31. PT KNOLL Roll PSD Plot, 2.8 Ft Bow Seas

TABLE C-XXXI
PT KNOLL Roll PSD
2.8 Ft Bow Seas

PT KNOLL ROLL:2.8 FT BOW SEAS 16 KTS

ROLL Energy Spectrum
Tested 2 AUGUST 83

Run No. BOW QTR., Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	4.285645E+00
.042969	6.965821E+00
.050781	3.264160E+00
.062500	1.960450E+01
.074219	3.390014E+00
.078125	7.768310E+00
.082031	1.486768E+01
.085938	8.723144E+00
.093750	1.241699E+01
.105469	2.663330E+00
.109375	3.640014E+00
.117188	1.835816E+00
.121094	1.347046E+00
.148438	7.223632E+00
.152344	4.592530E+00
.156250	5.633789E+00
.160156	7.304688E+00
.164063	4.917480E+00
.171875	2.082520E+01
.179688	9.744629E+00
.183594	1.471240E+01
.191406	4.918213E+00
.195313	9.621582E+00
.203125	2.730664E+01
.207031	1.292725E+01
.214844	2.615918E+01
.218750	2.258496E+01
.226563	2.782130E+01
.234375	8.391602E+00
.242188	1.314795E+01
.257813	4.170899E+00
.261719	7.614990E+00
.273438	1.617066E+00
.312500	1.178833E+00
.351563	8.218690E-01
.390625	3.091888E-01
.429688	9.250642E-02
.468750	9.550858E-02
.507813	5.713845E-02
.546875	8.135224E-02
.585938	4.421806E-02
.625000	5.808640E-02
.664063	2.339173E-02
.703125	1.597309E-02
.742188	1.384020E-02
.781250	3.401875E-03
.820313	1.935899E-03
.859375	1.917362E-03
.898438	9.451509E-04
.937500	2.899467E-04

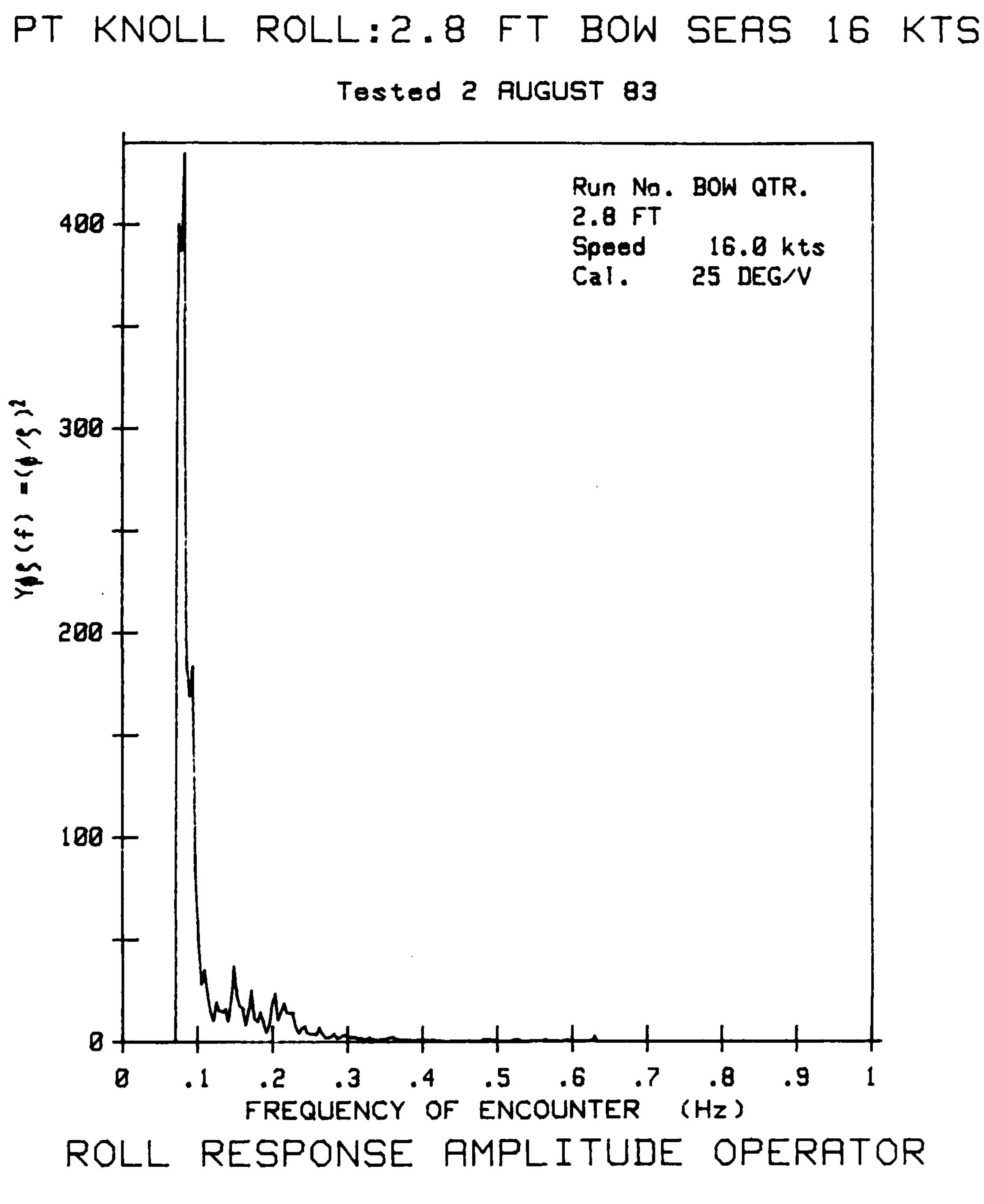


FIGURE C-32. PT KNOLL Roll RAO Plot, 2.8 Ft Bow Seas

TABLE C-XXXII
PT KNOLL Roll RAO
2.8 Ft Bow Seas

PT KNOLL ROLL:2.8 FT BOW SEAS 16 KTS

ROLL Response Amplitude Operator
Tested 2 AUGUST 83

Run No. BOW QTR., Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE RAO
.039063	0.000000E+00
.074219	4.003267E+02
.078125	3.870774E+02
.082031	4.348993E+02
.089844	1.686635E+02
.093750	1.833995E+02
.105469	2.818375E+01
.117188	1.506328E+01
.156250	1.746552E+01
.191406	4.521980E+00
.195313	8.643190E+00
.234375	4.206796E+00
.273438	1.976227E+00
.312500	1.785930E+00
.351563	1.667483E+00
.390625	7.842433E-01
.429688	1.692144E-01
.468750	2.708809E-01
.507813	2.941467E-01
.546875	4.715660E-01
.585938	2.323626E-01
.625000	4.946575E-01
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

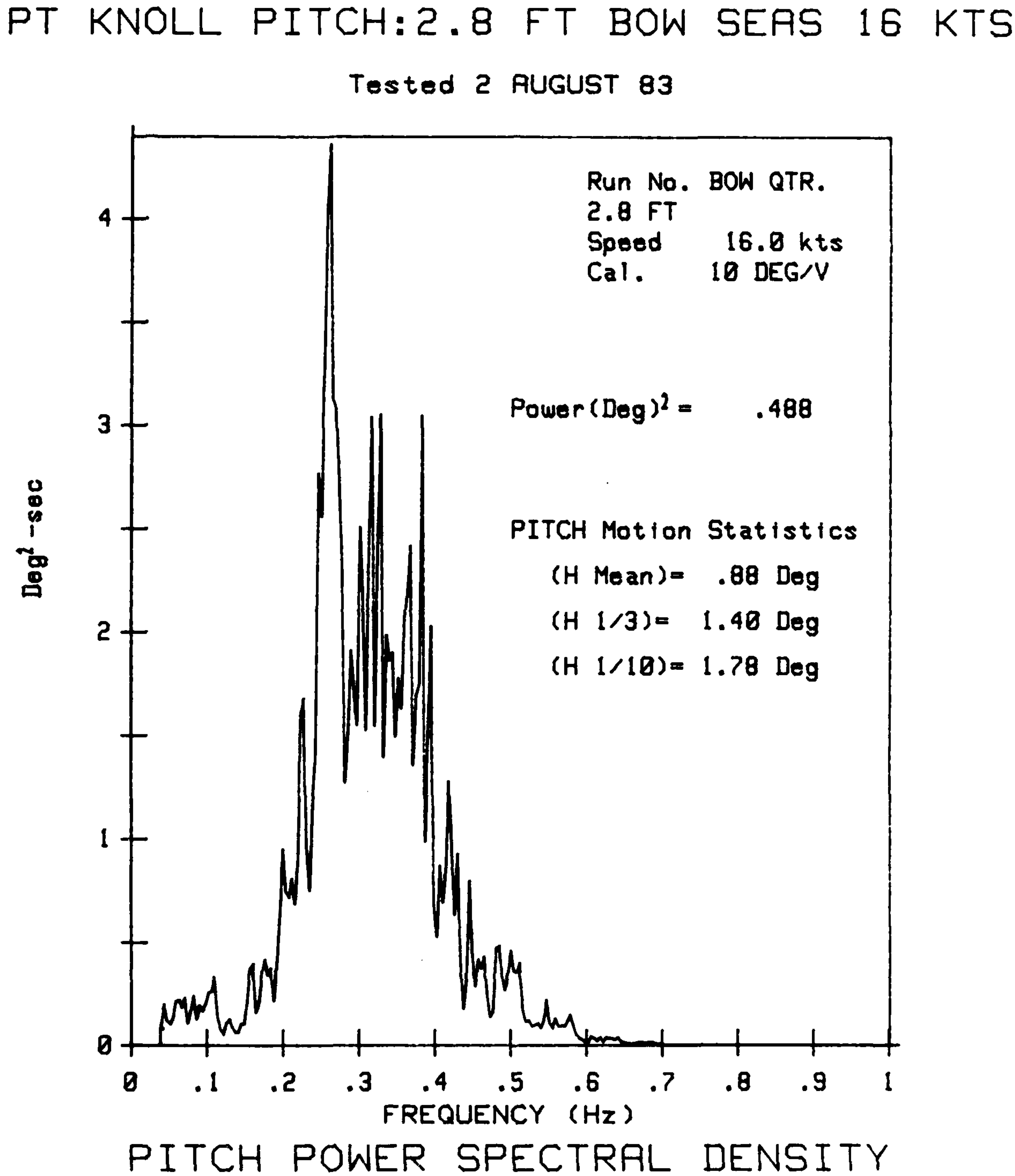


FIGURE C-33. PT KNOLL Pitch PSD Plot, 2.8 Ft Bow Seas

TABLE C-XXXIII
PT KNOLL Pitch PSD
2.8 Ft Bow Seas

PT KNOLL PITCH:2.8 FT BOW SEAS 16 KTS

PITCH Energy Spectrum
Tested 2 AUGUST 83

Run No. BOW QTR., Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	8.683778E-02
.042969	2.007066E-01
.078125	1.677170E-01
.117188	7.827378E-02
.156250	3.750763E-01
.195313	6.292419E-01
.199219	9.497986E-01
.207031	7.182922E-01
.210938	8.050538E-01
.214844	6.855469E-01
.226563	1.678650E+00
.234375	7.479248E-01
.246094	2.767334E+00
.250000	2.553834E+00
.261719	4.360352E+00
.273438	2.724610E+00
.281250	1.269714E+00
.289063	1.912720E+00
.296875	1.546326E+00
.300781	2.506470E+00
.308594	1.523499E+00
.312500	2.482299E+00
.316406	3.039307E+00
.320313	1.543640E+00
.328125	3.050050E+00
.332031	1.391663E+00
.335938	1.924986E+00
.339844	1.865845E+00
.343750	1.900390E+00
.347656	1.493774E+00
.351563	1.775939E+00
.355469	1.629272E+00
.367188	2.416749E+00
.371094	1.353638E+00
.382813	3.047242E+00
.386719	9.834595E-01
.390625	1.520508E+00
.394531	2.031616E+00
.402344	5.227661E-01
.406250	8.717957E-01
.410156	6.904298E-01
.417969	1.280640E+00
.425781	6.290283E-01
.429688	9.282227E-01
.437500	1.753845E-01
.445313	7.981262E-01
.453125	2.847290E-01
.468750	2.507171E-01
.484375	4.813538E-01
.500000	4.574280E-01

TABLE C-XXXIII (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.507813	3.545837E-01
.519531	1.128654E-01
.546875	2.200317E-01
.585938	5.065536E-02
.625000	3.503037E-02
.664063	1.186371E-02
.703125	1.504660E-03
.742188	1.628160E-03
.781250	8.561314E-04
.820313	6.467104E-04
.859375	1.665115E-03
.898438	3.485083E-04
.937500	8.778870E-04
.976563	8.642077E-04

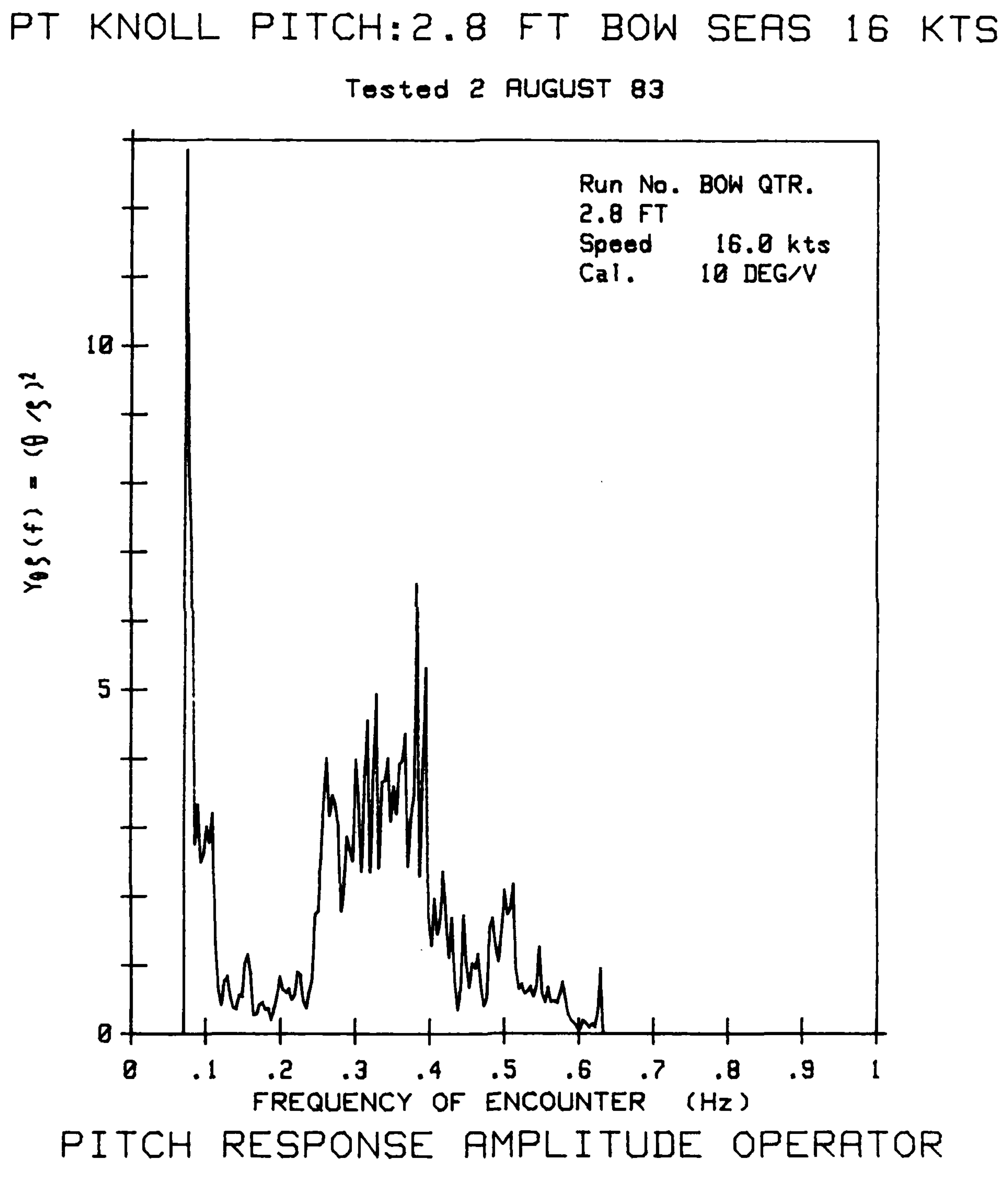


FIGURE C-34. PT KNOLL Pitch RAO Plot, 2.8 Ft Bow Seas

TABLE C-XXXIV
PT KNOLL Pitch RAO
2.8 Ft Bow Seas

PT KNOLL PITCH:2.8 FT BOW SEAS 16 KTS

PITCH Response Amplitude Operator
Tested 2 AUGUST 83

Run No. BOW QTR., Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE RAO
.039063	0.000000E+00
.074219	1.285933E+01
.078125	8.356958E+00
.085938	2.747699E+00
.089844	3.333806E+00
.093750	2.495780E+00
.101563	3.013594E+00
.105469	2.778750E+00
.109375	3.209465E+00
.117188	6.422539E-01
.121094	4.172413E-01
.156250	1.162788E+00
.164063	2.699045E-01
.195313	5.652560E-01
.234375	3.749424E-01
.261719	4.015382E+00
.265625	3.162661E+00
.269531	3.468803E+00
.273438	3.329763E+00
.281250	1.775470E+00
.289063	2.874387E+00
.296875	2.503327E+00
.300781	3.995831E+00
.308594	2.350827E+00
.312500	3.760680E+00
.316406	4.564040E+00
.320313	2.340891E+00
.328125	4.944285E+00
.332031	2.402547E+00
.343750	4.008858E+00
.347656	3.089733E+00
.351563	3.603188E+00
.355469	3.201507E+00
.367188	4.372846E+00
.371094	2.424373E+00
.382813	6.550342E+00
.386719	2.288567E+00
.390625	3.856699E+00
.394531	5.322574E+00
.402344	1.275585E+00
.406250	1.970429E+00
.410156	1.443423E+00
.417969	2.369762E+00
.425781	1.105355E+00
.429688	1.697922E+00
.437500	3.490347E-01
.445313	1.737334E+00
.453125	6.757845E-01
.468750	7.110825E-01
.484375	1.687170E+00

TABLE C-XXXIV (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE
.500000	2.101734E+00
.503906	1.744244E+00
.507813	1.825384E+00
.511719	2.180087E+00
.519531	6.549569E-01
.546875	1.275435E+00
.585938	2.661901E-01
.625000	2.983148E-01
.632813	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

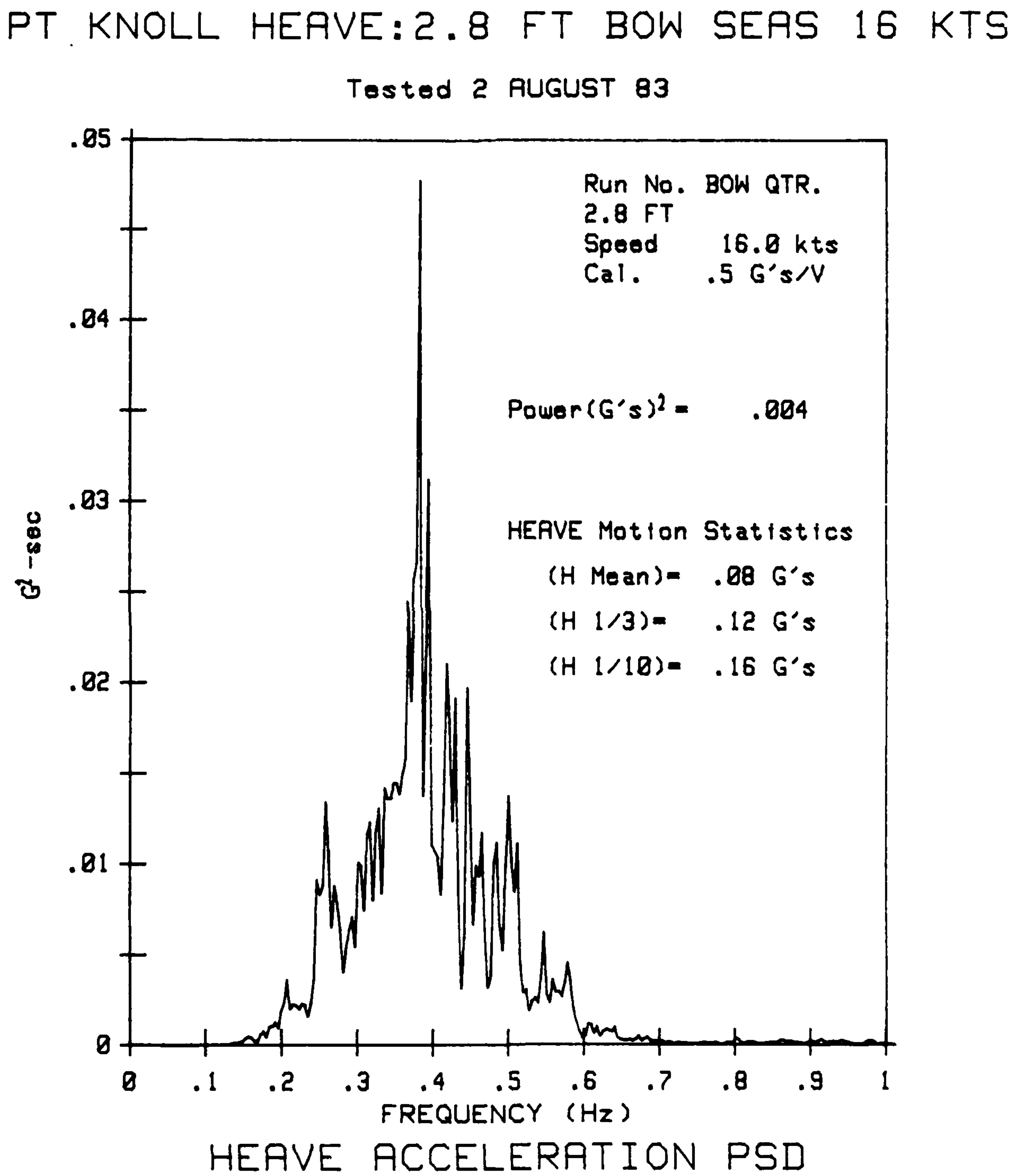


FIGURE C-35. PT KNOLL Heave PSD Plot, 2.8 Ft Bow Seas

TABLE C-XXXV
PT KNOLL Heave PSD
2.8 Ft Bow Seas

PT KNOLL HEAVE:2.8 FT BOW SEAS 16 KTS

HEAVE Energy Spectrum
Tested 2 AUGUST 83

Run No. BOW QTR., Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.039063	8.603674E-07
.054688	1.536100E-06
.078125	2.732267E-06
.117188	4.314352E-06
.156250	4.608035E-04
.195313	9.624958E-04
.207031	3.609419E-03
.234375	1.578331E-03
.246094	9.130478E-03
.250000	8.297443E-03
.257813	1.341438E-02
.265625	6.462813E-03
.269531	8.798600E-03
.273438	7.791995E-03
.281250	4.002810E-03
.292969	7.079840E-03
.296875	5.416394E-03
.300781	1.007605E-02
.308594	7.422925E-03
.312500	1.166868E-02
.316406	1.231289E-02
.320313	7.964611E-03
.328125	1.306391E-02
.332031	8.347035E-03
.335938	1.420832E-02
.339844	1.358461E-02
.351563	1.444244E-02
.355469	1.383924E-02
.367188	2.448749E-02
.371094	1.896190E-02
.382813	4.771995E-02
.386719	1.374435E-02
.390625	2.177238E-02
.394531	3.121186E-02
.410156	8.279800E-03
.417969	2.105331E-02
.425781	1.233578E-02
.429688	1.913643E-02
.437500	3.097653E-03
.445313	1.971341E-02
.453125	6.660699E-03
.457031	9.936333E-03
.460938	9.299755E-03
.464844	1.173353E-02
.468750	6.356478E-03
.472656	3.174067E-03
.484375	1.118898E-02
.492188	5.268574E-03
.500000	1.373148E-02
.507813	8.458614E-03

TABLE C-XXXV (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.511719	1.109934E-02
.519531	2.852797E-03
.546875	6.244421E-03
.554688	2.313853E-03
.585938	2.021312E-03
.625000	7.100106E-04
.664063	2.272874E-04
.703125	1.895354E-04
.742188	4.315749E-05
.781250	1.806206E-05
.820313	1.485199E-04
.859375	2.266765E-04
.898438	1.836941E-04
.937500	1.910776E-04
.976563	2.139136E-04

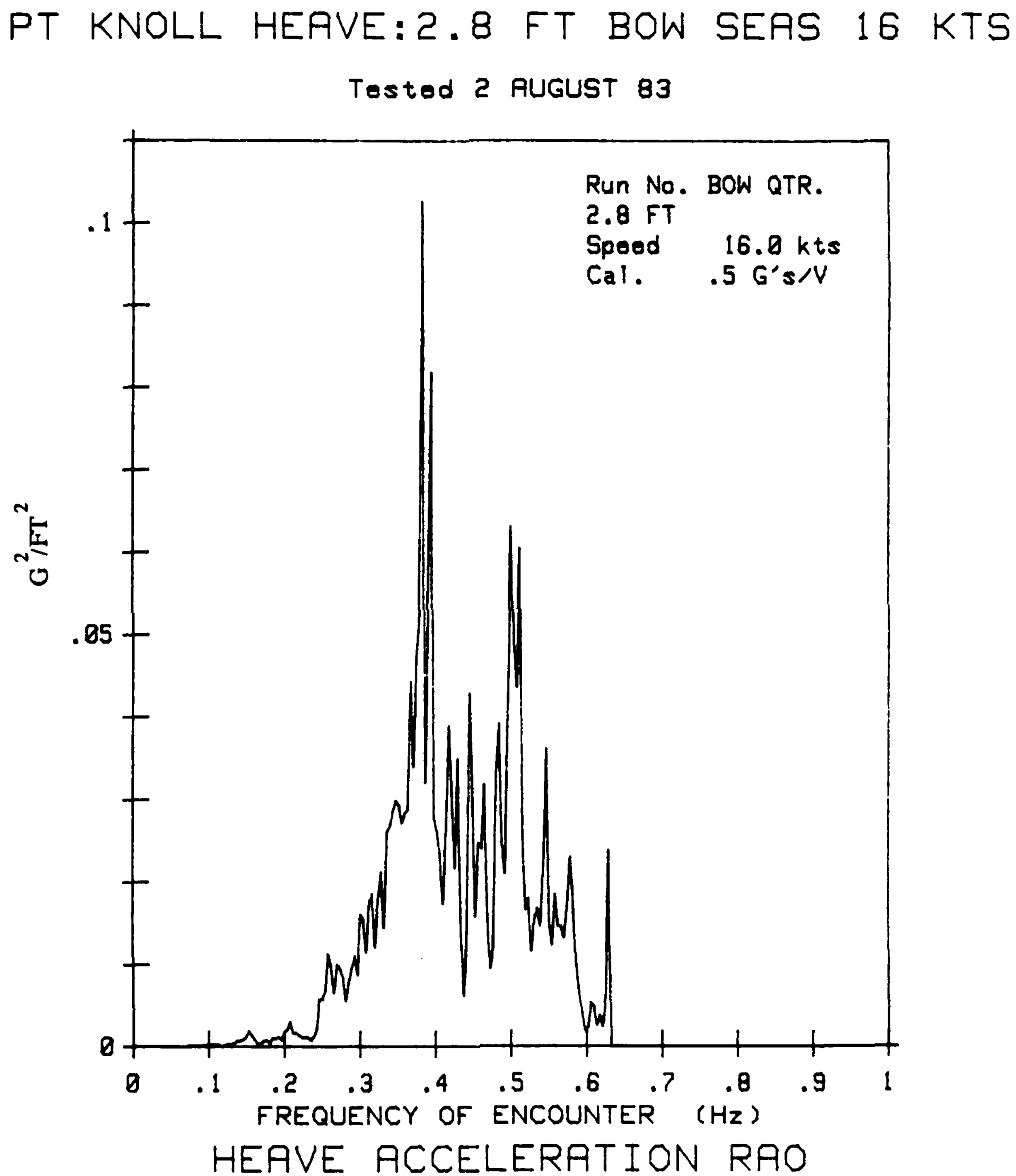


FIGURE C-36. PT KNOLL Heave RAO Plot, 2.8 Ft Bow Seas

TABLE C-XXXVI
PT KNOLL Heave RAO
2.8 Ft Bow Seas

PT KNOLL HEAVE:2.8 FT BOW SEAS 16 KTS

HEAVE Response Amplitude Operator
Tested 2 AUGUST 83

Run No. BOW QTR., Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	G^2/FT^2
.039063	0.000000E+00
.078125	1.361427E-04
.117188	3.540023E-05
.156250	1.428554E-03
.195313	8.646223E-04
.234375	7.912336E-04
.257813	1.128160E-02
.273438	9.522649E-03
.281250	5.597219E-03
.292969	1.103873E-02
.300781	1.606330E-02
.308594	1.145391E-02
.312500	1.767804E-02
.316406	1.848991E-02
.320313	1.207813E-02
.328125	2.117726E-02
.332031	1.441021E-02
.347656	2.986594E-02
.351563	2.930215E-02
.355469	2.719401E-02
.367188	4.430746E-02
.371094	3.396089E-02
.382813	1.025787E-01
.386719	3.198390E-02
.390625	5.522466E-02
.394531	8.177106E-02
.410156	1.730988E-02
.417969	3.895813E-02
.425781	2.167694E-02
.429688	3.500471E-02
.437500	6.164675E-03
.445313	4.291148E-02
.453125	1.580871E-02
.457031	2.465280E-02
.460938	2.408443E-02
.464844	3.177993E-02
.468750	1.802821E-02
.472656	9.441632E-03
.484375	3.921798E-02
.492188	2.098380E-02
.500000	6.309171E-02
.507813	4.354465E-02
.511719	6.050397E-02
.519531	1.655475E-02
.523438	1.795805E-02
.527344	1.156367E-02
.535156	1.681630E-02
.539063	1.468672E-02
.546875	3.619638E-02
.554688	1.233540E-02

TABLE C-XXXVI (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	G^2/FT^2
.558594	1.852258E-02
.570313	1.317968E-02
.578125	2.302527E-02
.585938	1.062184E-02
.597656	1.971403E-03
.625000	6.046373E-03
.628906	2.385721E-02
.632813	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

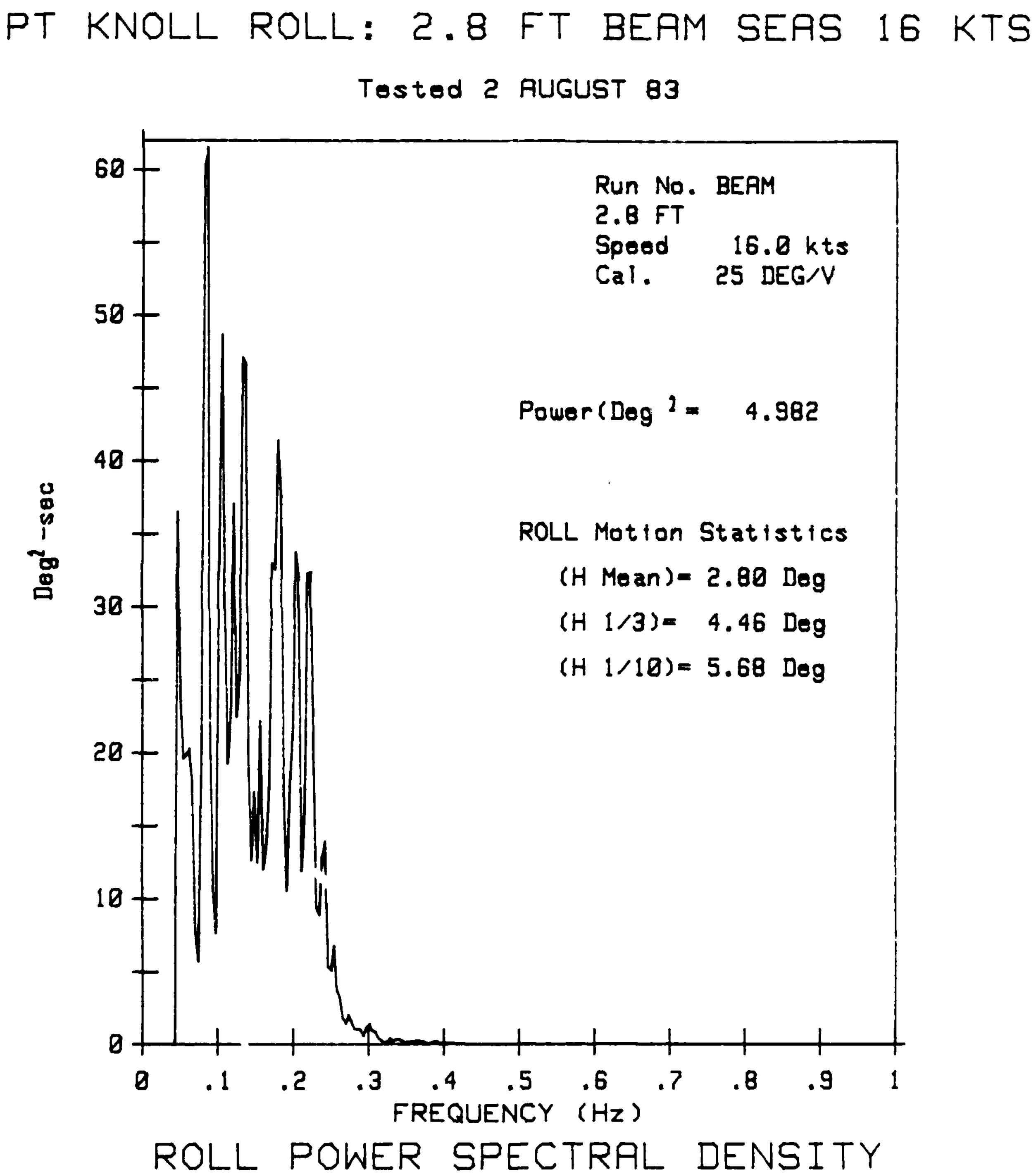


FIGURE C-37. PT KNOLL Roll PSD Plot, 2.8 Ft Beam Seas

TABLE C- XXXVII
PT KNOLL Roll PSD
2.8 Ft Beam Seas

PT KNOLL ROLL: 2.8 FT BEAM SEAS 16 KTS

ROLL Energy Spectrum
Tested 2 AUGUST 83

Run No. BEAM, Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.046875	3.653710E+01
.054688	1.955176E+01
.062500	2.022070E+01
.074219	5.696290E+00
.078125	1.838086E+01
.085938	6.150390E+01
.097656	7.603760E+00
.105469	4.864648E+01
.113281	1.918848E+01
.117188	2.265136E+01
.121094	3.704493E+01
.125000	2.241699E+01
.132813	4.708789E+01
.144531	1.257178E+01
.148438	1.729493E+01
.152344	1.244531E+01
.156250	2.216894E+01
.160156	1.194434E+01
.171875	3.297266E+01
.175781	3.254688E+01
.179688	4.137304E+01
.191406	1.049219E+01
.195313	1.778027E+01
.203125	3.374219E+01
.210938	1.183838E+01
.222656	3.235742E+01
.234375	8.870117E+00
.242188	1.391846E+01
.250000	5.109864E+00
.253906	6.737549E+00
.269531	1.431885E+00
.273438	2.023194E+00
.312500	4.582062E-01
.351563	1.569824E-01
.390625	1.803741E-01
.429688	4.533938E-02
.468750	1.168632E-02
.507813	2.676106E-02
.546875	2.653408E-02
.585938	2.160549E-02
.625000	2.056459E-02
.664063	2.450658E-02
.703125	1.067495E-02
.742188	7.770776E-03
.781250	3.528118E-03
.820313	3.913165E-03
.859375	2.459406E-03
.898438	6.039142E-04
.937500	4.309862E-04

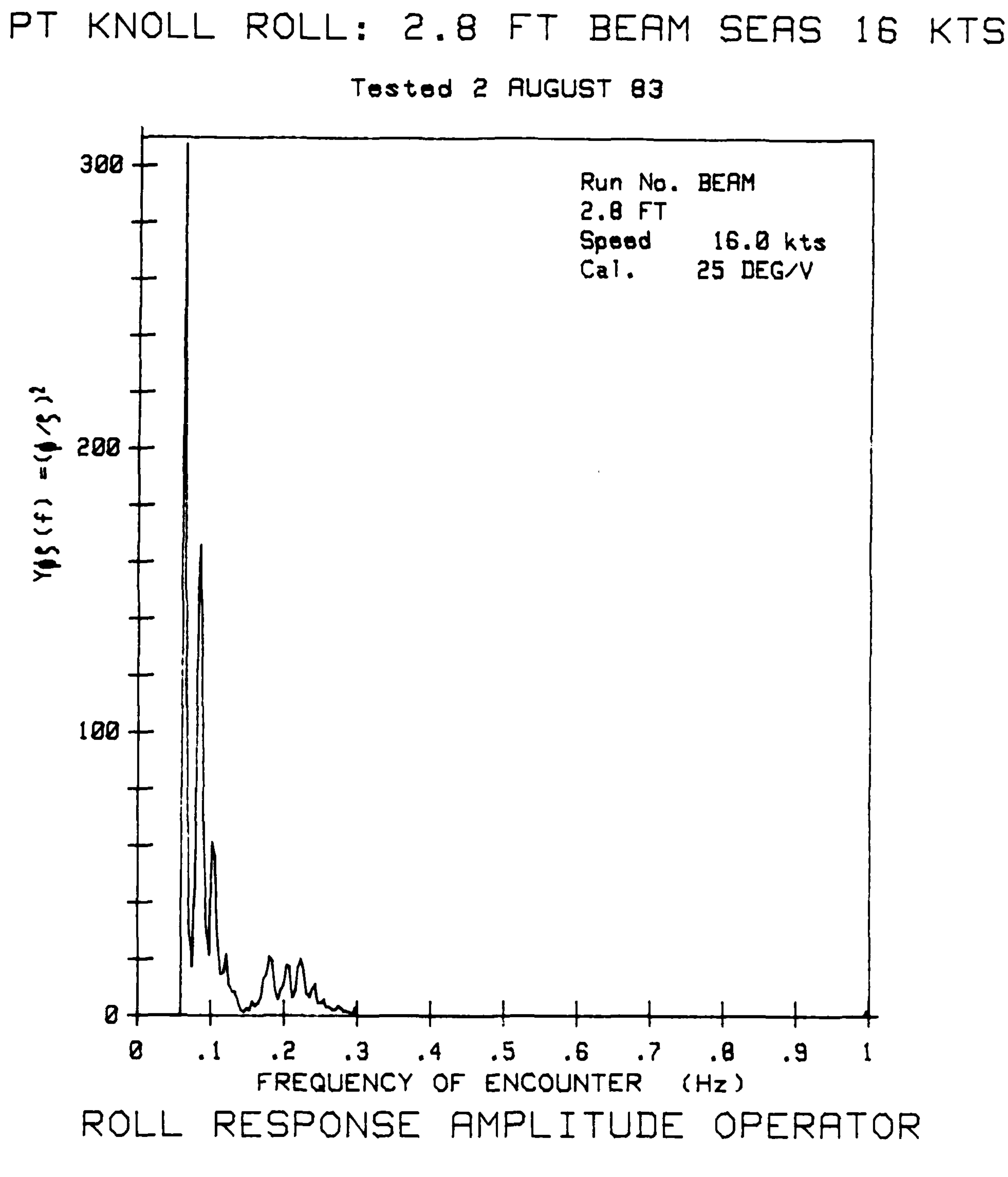


FIGURE C-38. PT KNOLL Roll RAO Plot, 2.8 Ft Beam Seas

TABLE C-XXXVIII
PT KNOLL Roll RAO
2.8 Ft Beam Seas

PT KNOLL ROLL: 2.8 FT BEAM SEAS 16 KTS

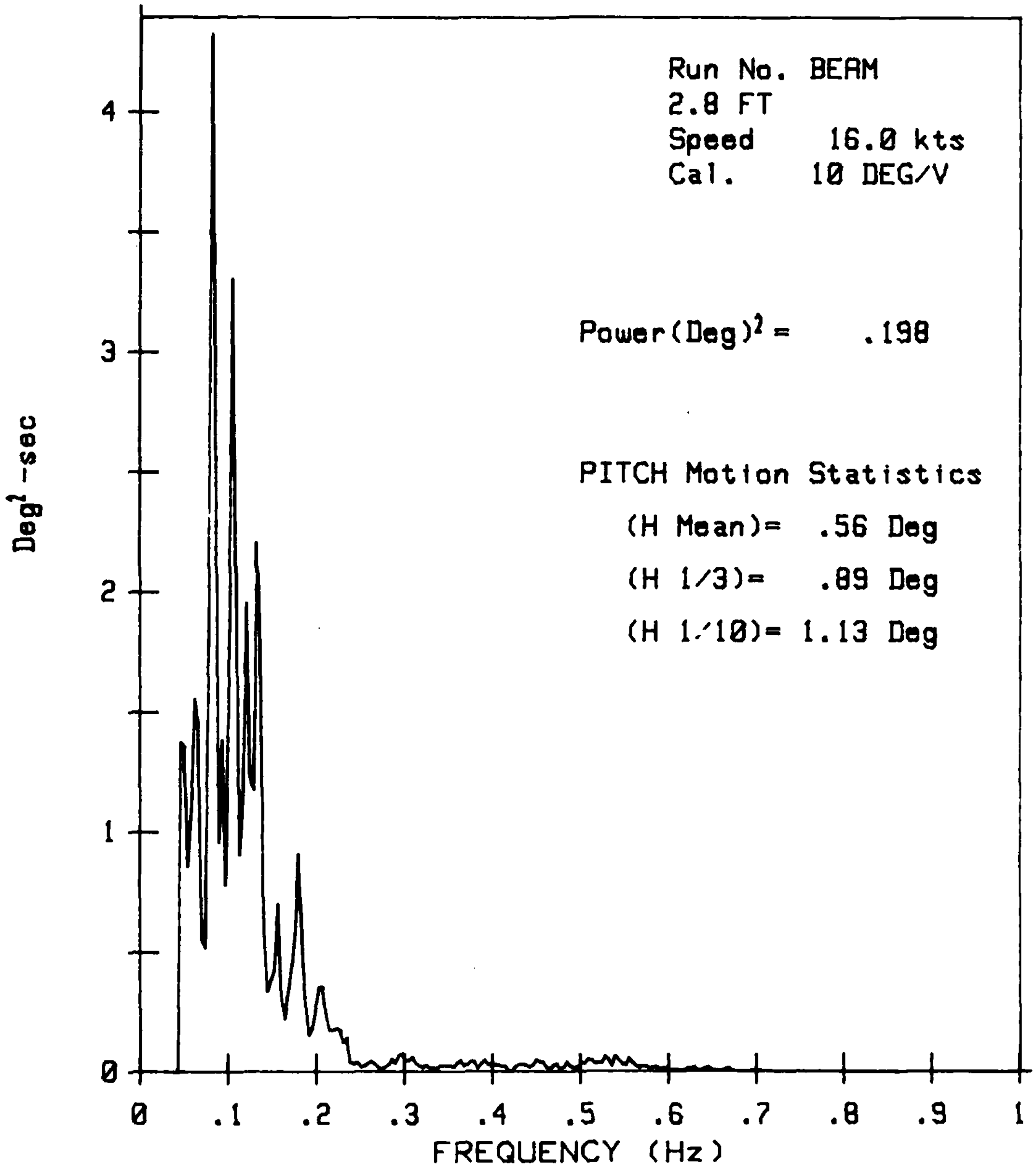
ROLL Response Amplitude Operator
Tested 2 AUGUST 83

Run No. BEAM, Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE RAO
.039063	0.000000E+00
.062500	3.075758E+02
.074219	1.724229E+01
.078125	4.485274E+01
.085938	1.659159E+02
.097656	2.134418E+01
.101563	6.115202E+01
.113281	1.440952E+01
.117188	1.530379E+01
.156250	4.963160E+00
.195313	9.268360E+00
.234375	6.848711E+00
.273438	3.424381E+00
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

PT KNOLL PITCH:2.8 FT BEAM SEAS 16 KTS

Tested 2 AUGUST 83



PITCH POWER SPECTRAL DENSITY

FIGURE C-39. PT KNOLL Pitch PSD Plot, 2.8 Ft Beam Seas

TABLE C-XXXIX
PT KNOLL Pitch PSD
2.8 Ft Beam Seas

PT KNOLL PITCH:2.8 FT BEAM SEAS 16 KTS

PITCH Energy Spectrum
Tested 2 AUGUST 83

Run No. BEAM, Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.046875	1.376282E+00
.054688	8.532104E-01
.062500	1.556885E+00
.074219	5.165101E-01
.078125	1.774658E+00
.082031	4.330811E+00
.089844	9.532470E-01
.093750	1.384033E+00
.097656	7.748718E-01
.105469	3.307006E+00
.113281	9.019470E-01
.117188	1.176819E+00
.121094	1.955994E+00
.128906	1.176514E+00
.132813	2.206666E+00
.144531	3.346253E-01
.156250	7.003174E-01
.164063	2.209931E-01
.179688	9.087829E-01
.191406	1.512375E-01
.195313	1.876144E-01
.234375	1.400909E-01
.273438	1.027966E-02
.312500	3.573227E-02
.351563	2.557086E-02
.390625	4.850960E-02
.429688	3.001499E-02
.468750	2.685642E-02
.507813	5.021667E-02
.546875	3.379250E-02
.585938	2.143955E-02
.625000	1.561832E-02
.664063	1.338339E-02
.703125	6.163120E-03
.742188	3.277182E-03
.781250	5.595685E-04
.820313	6.396771E-04
.859375	3.115982E-04
.898438	3.828109E-04
.937500	1.111329E-03
.976563	5.717277E-04

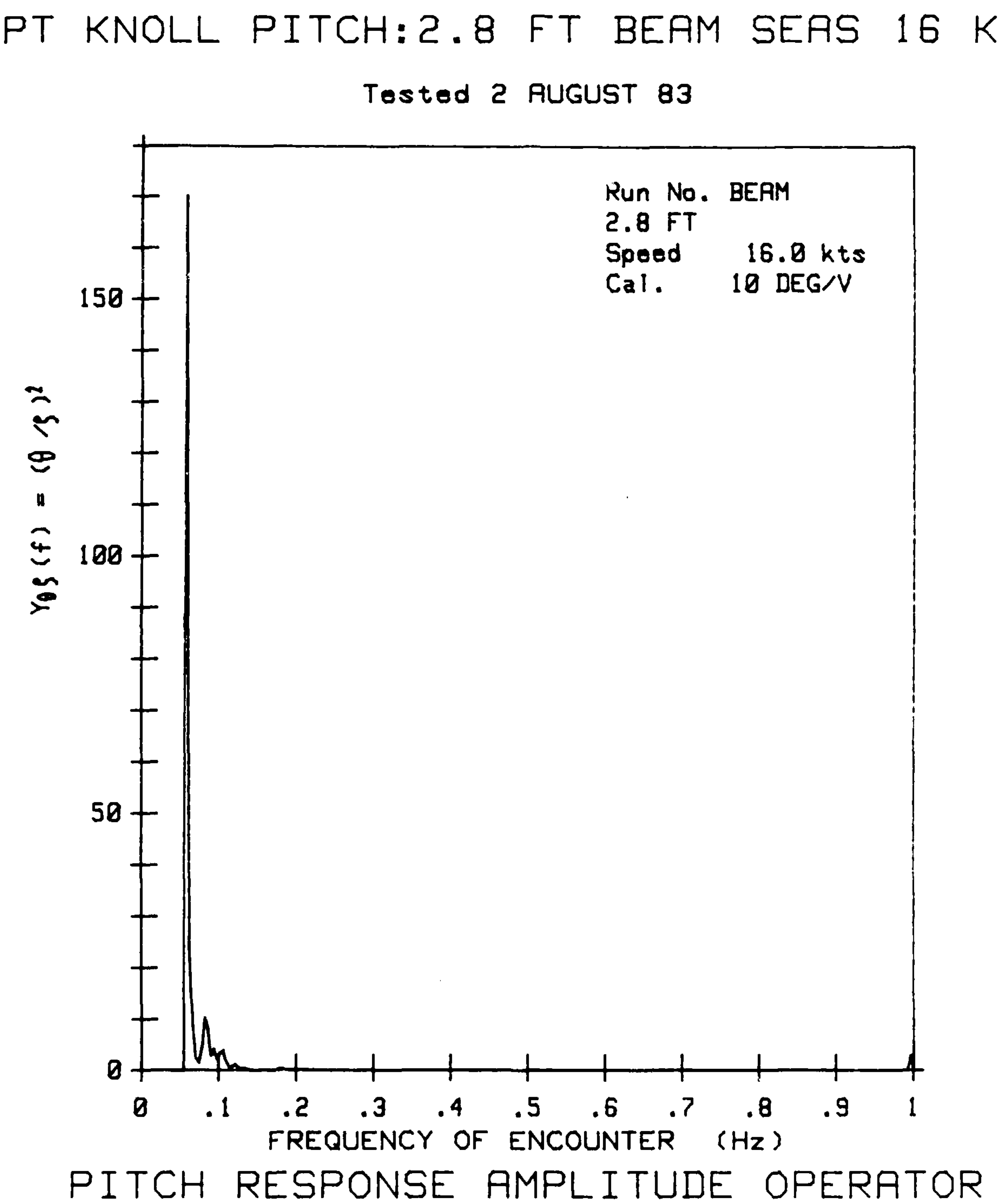


FIGURE C-40. PT KNOLL Pitch RAO Plot, 2.8 Ft Beam Seas

TABLE C-XL
PT KNOLL Pitch RAO
2.8 Ft Beam Seas

PT KNOLL PITCH:2.8 FT BEAM SEAS 16 KTS

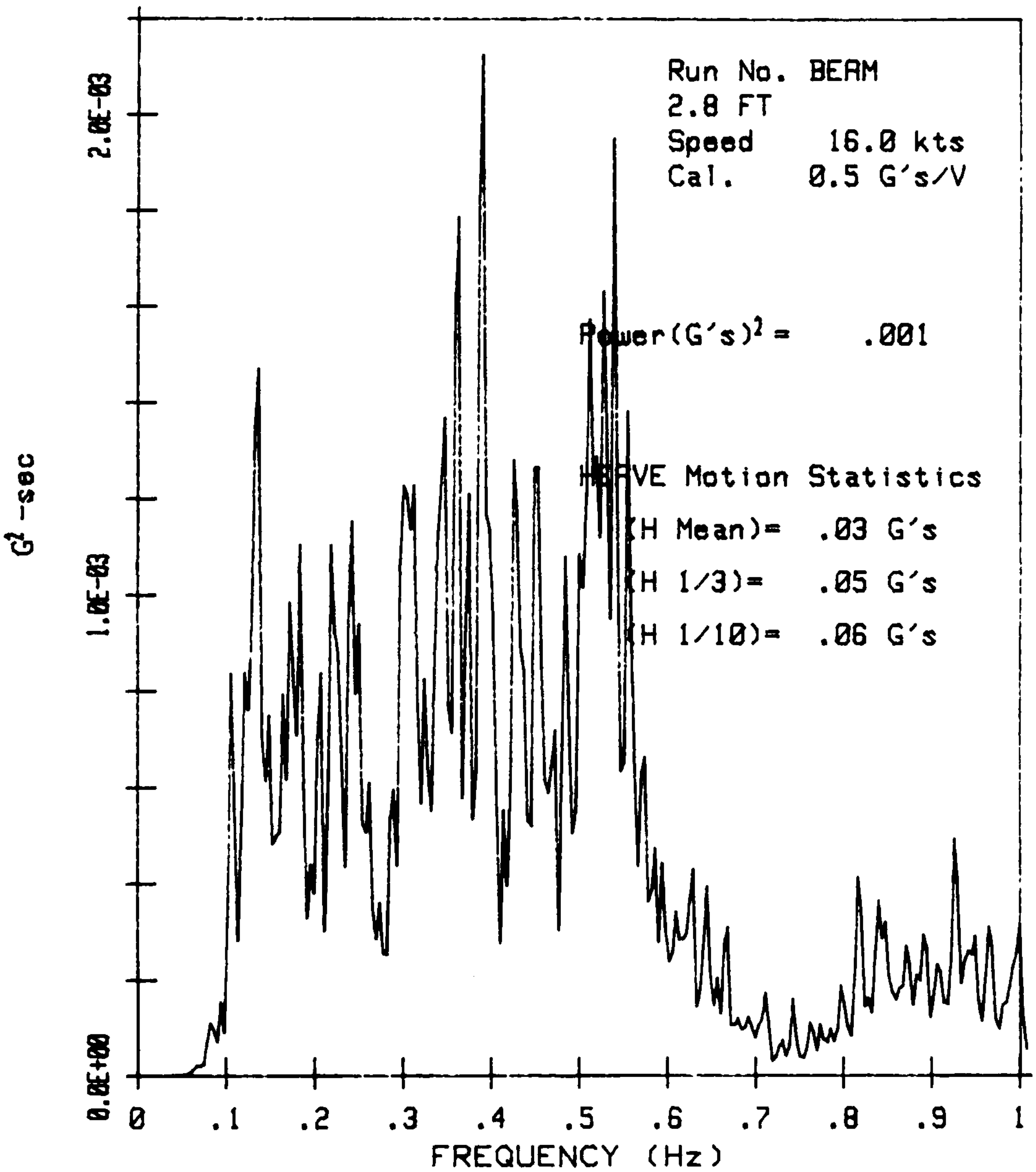
PITCH Response Amplitude Operator
Tested 2 AUGUST 83

Run No. BEAM, Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE RAO
.039063	0.000000E+00
.058594	1.701894E+02
.074219	1.563441E+00
.078125	4.330496E+00
.117188	7.950862E-01
.156250	1.567863E-01
.195313	9.779816E-02
.234375	1.081657E-01
.273438	1.739895E-02
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

PT KNOLL HEAVE:2.8 FT BEAM SEAS 16 KTS

Tested 2 AUGUST 83



HEAVE ACCELERATION PSD

FIGURE C-41. PT KNOLL Heave PSD Plot, 2.8 Ft Beam Seas

TABLE C-XLI
PT KNOLL Heave PSD
2.8 Ft Beam Seas

PT KNOLL HEAVE:2.8 FT BEAM SEAS 16 KTS

HEAVE Energy Spectrum
Tested 2 AUGUST 83

Run No. BEAM, Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.039063	1.339416E-06
.042969	1.808104E-06
.078125	7.145851E-05
.093750	1.535118E-04
.105469	8.361042E-04
.113281	2.800971E-04
.117188	5.324186E-04
.121094	8.375942E-04
.125000	7.610022E-04
.136719	1.468182E-03
.144531	6.121397E-04
.148438	7.481277E-04
.152344	4.824251E-04
.156250	4.979968E-04
.164063	7.922947E-04
.167969	6.162822E-04
.171875	9.836555E-04
.179688	7.075965E-04
.183594	1.104474E-03
.191406	3.278702E-04
.195313	4.395246E-04
.199219	3.802925E-04
.207031	8.372664E-04
.210938	3.006160E-04
.218750	1.104712E-03
.234375	4.335642E-04
.242188	1.153052E-03
.246094	7.939339E-04
.250000	9.391010E-04
.257813	5.064606E-04
.261719	6.096066E-04
.269531	2.845973E-04
.273438	3.601312E-04
.281250	2.525896E-04
.289063	5.947053E-04
.292969	4.380494E-04
.300781	1.226544E-03
.308594	1.136303E-03
.312500	1.227677E-03
.320313	5.659758E-04
.324219	8.253157E-04
.332031	5.506574E-04
.347656	1.366973E-03
.351563	7.699430E-04
.355469	7.141829E-04
.363281	1.784682E-03
.367188	5.780459E-04
.375000	1.210093E-03
.378906	5.334616E-04
.390625	2.122522E-03

TABLE C-XLI (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.410156	2.760589E-04
.414063	5.533696E-04
.417969	3.955066E-04
.425781	1.280785E-03
.429688	1.165092E-03
.445313	5.217493E-04
.449219	1.264870E-03
.464844	5.888939E-04
.468750	6.508827E-04
.472656	7.181466E-04
.476563	3.030450E-04
.484375	1.080096E-03
.492188	5.052686E-04
.500000	1.085758E-03
.503906	1.016736E-03
.507813	1.196265E-03
.511719	1.573443E-03
.515625	1.264393E-03
.519531	1.287341E-03
.523438	1.120329E-03
.527344	1.630843E-03
.535156	9.499789E-04
.539063	1.949728E-03
.546875	6.337762E-04
.554688	1.382470E-03
.566406	4.360526E-04
.574219	6.633997E-04
.578125	3.629475E-04
.585938	4.751682E-04
.589844	2.774000E-04
.593750	4.417002E-04
.601563	2.387986E-04
.609375	3.421456E-04
.613281	2.852530E-04
.625000	3.678947E-04
.628906	4.292726E-04
.632813	1.430959E-04
.644531	3.946573E-04
.652344	1.472756E-04
.664063	2.749712E-04
.667969	3.090054E-04
.671875	1.049600E-04
.703125	1.056455E-04
.742188	1.597628E-04
.781250	7.029250E-05
.816406	4.135966E-04
.820313	3.320723E-04
.824219	1.433715E-04
.839844	3.639608E-04
.843750	2.859979E-04
.847656	3.195107E-04
.859375	1.592785E-04
.871094	2.710968E-04
.878906	1.462549E-04
.890625	2.941787E-04

TABLE C-XLI (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.898438	1.214482E-04
.906250	2.307147E-04
.925781	4.928709E-04
.933594	1.915098E-04
.937500	2.393872E-04
.941406	2.597720E-04
.945313	2.538562E-04
.949219	2.906173E-04
.957031	1.136586E-04
.964844	3.103466E-04
.976563	9.675696E-05

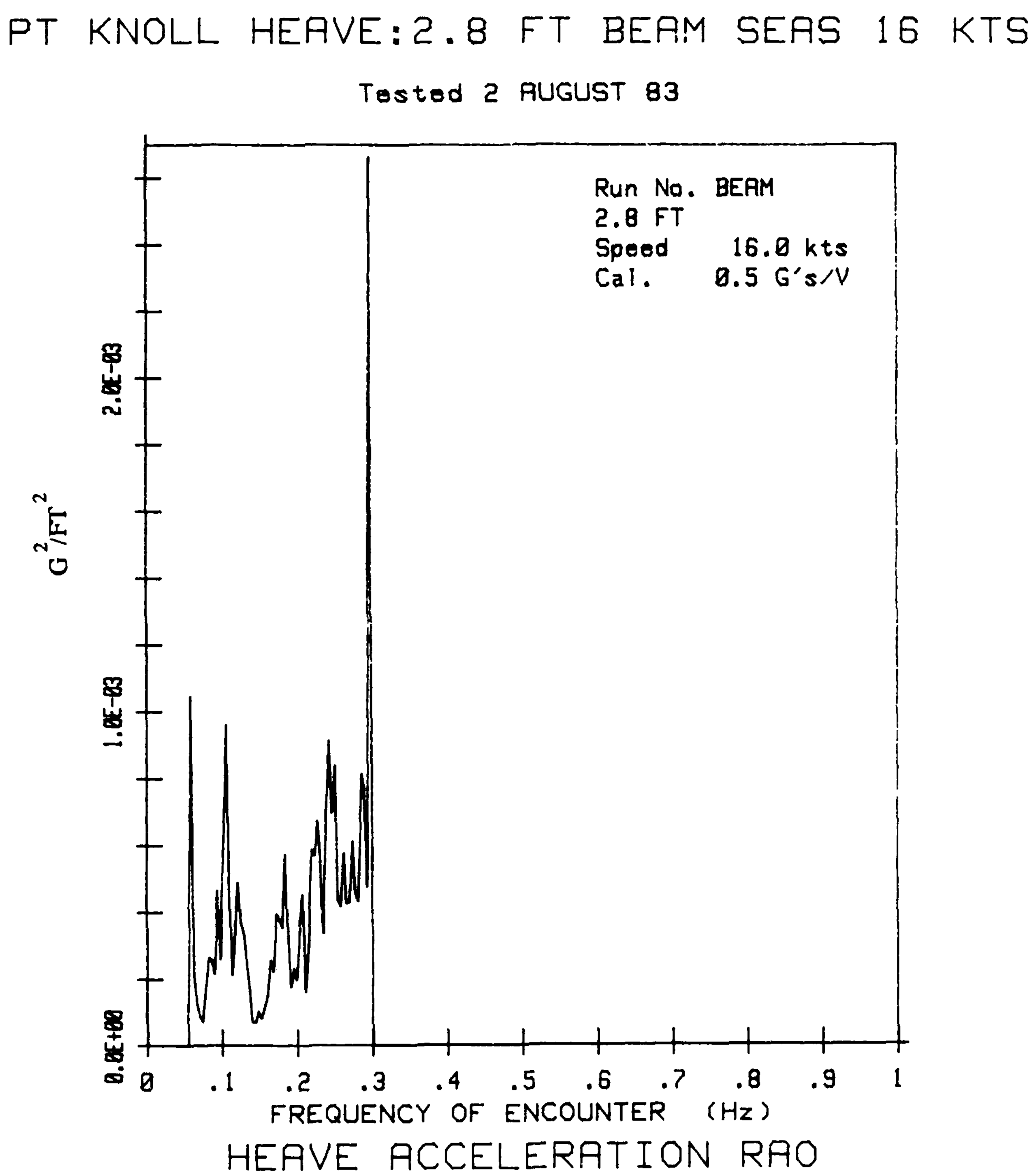


FIGURE C-42. PT KNOLL Heave RAO Plot, 2.8 Ft Beam Seas

TABLE C-XLII
PT KNOLL Heave RAO
2.8 Ft Beam Seas

PT KNOLL HEAVE:2.8 FT BEAM SEAS 16 KTS

HEAVE Response Amplitude Operator
Tested 2 AUGUST 83

Run No. BEAM, Speed 16 , SEAS 2.8 FT

FREQUENCY OF ENCOUNTER (HERTZ)	G^2/FT^2
.039063	0.000000E+00
.058594	1.046730E-03
.074219	7.188016E-05
.078125	1.743721E-04
.082031	2.629148E-04
.093750	4.651872E-04
.097656	2.586981E-04
.105469	9.597438E-04
.113281	2.103379E-04
.117188	3.597144E-04
.121094	4.882163E-04
.140625	6.972750E-05
.156250	1.114910E-04
.164063	2.554329E-04
.171875	3.947985E-04
.179688	3.531714E-04
.183594	5.723996E-04
.191406	1.744904E-04
.195313	2.291119E-04
.207031	4.508498E-04
.210938	1.606398E-04
.218750	5.876222E-04
.222656	5.703399E-04
.226563	6.720879E-04
.234375	3.347595E-04
.242188	9.125619E-04
.246094	6.955224E-04
.250000	8.377233E-04
.257813	4.172903E-04
.261719	5.748668E-04
.265625	4.249699E-04
.273438	6.095444E-04
.281250	4.314098E-04
.285156	8.140053E-04
.292969	4.732803E-04
.296875	2.661690E-03
.300781	0.000000E+00
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00

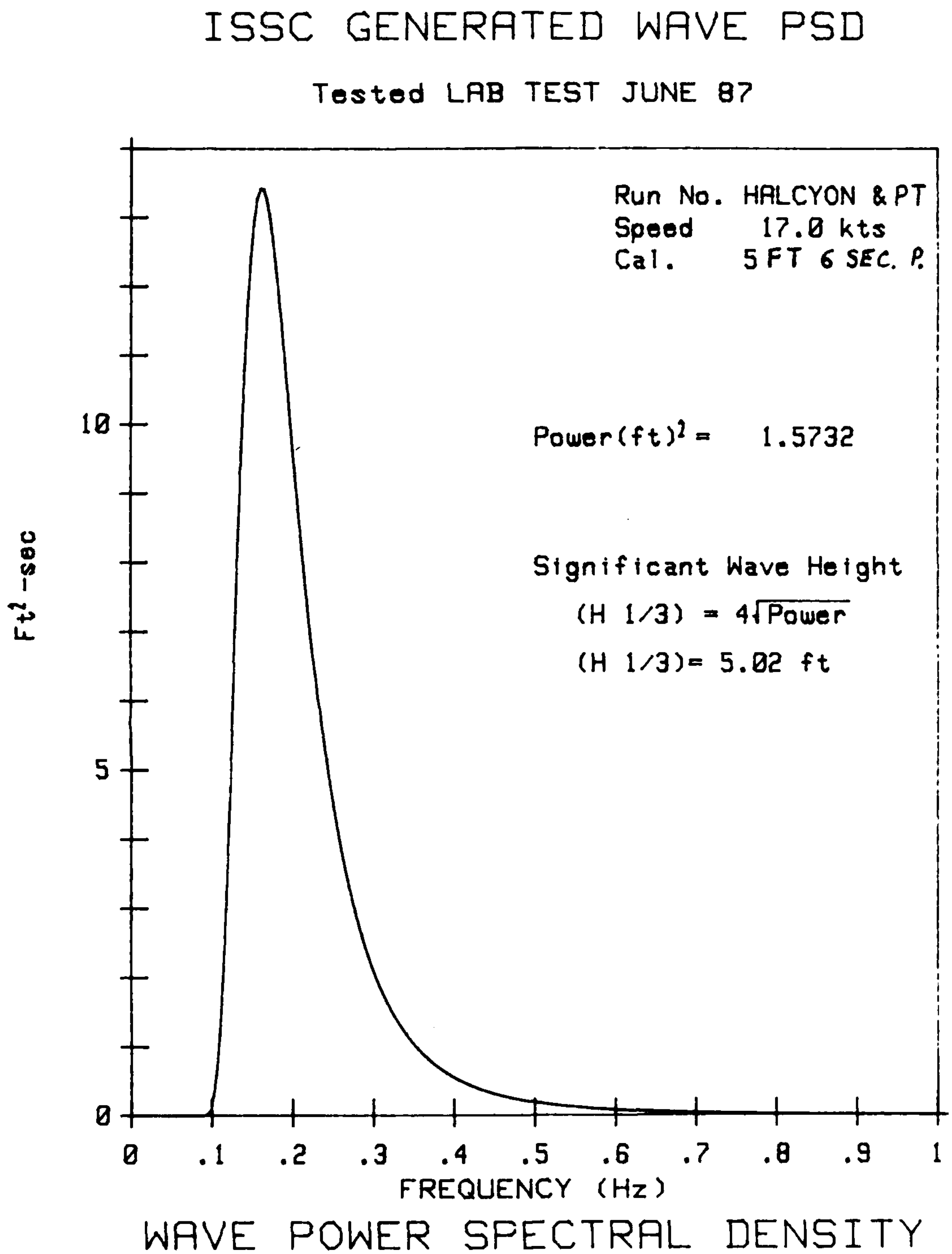


FIGURE C-43. Wave PSD Plot for HALCYON and PT KNOLL Seakeeping Comparison in 5 Ft Seas

TABLE C-XLIII
Wave PSD for HALCYON and PT KNOLL Seakeeping Comparison in 5 Ft Seas

ISSC GENERATED WAVE PSD

Wave Power Spectral Density
Tested LAB TEST JUNE 87

Run No. HALCYON & PT KNOLL

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (FT SQR-SEC)
.039063	0.000000E+00
.078125	4.075765E-06
.117188	2.986595E+00
.156250	1.327201E+01
.160156	1.341643E+01
.195313	1.031950E+01
.234375	5.781062E+00
.273438	3.116132E+00
.312500	1.731614E+00
.351563	1.006660E+00
.390625	6.120667E-01
.429688	3.875842E-01
.468750	2.543704E-01
.507813	1.722385E-01
.546875	1.198513E-01
.585938	8.541738E-02
.625000	6.217424E-02
.664063	4.611016E-02
.703125	3.477155E-02
.742188	2.661600E-02
.781250	2.064953E-02
.820313	1.621706E-02
.859375	1.287801E-02
.898438	1.033049E-02
.937500	8.364145E-03
.976563	6.830107E-03

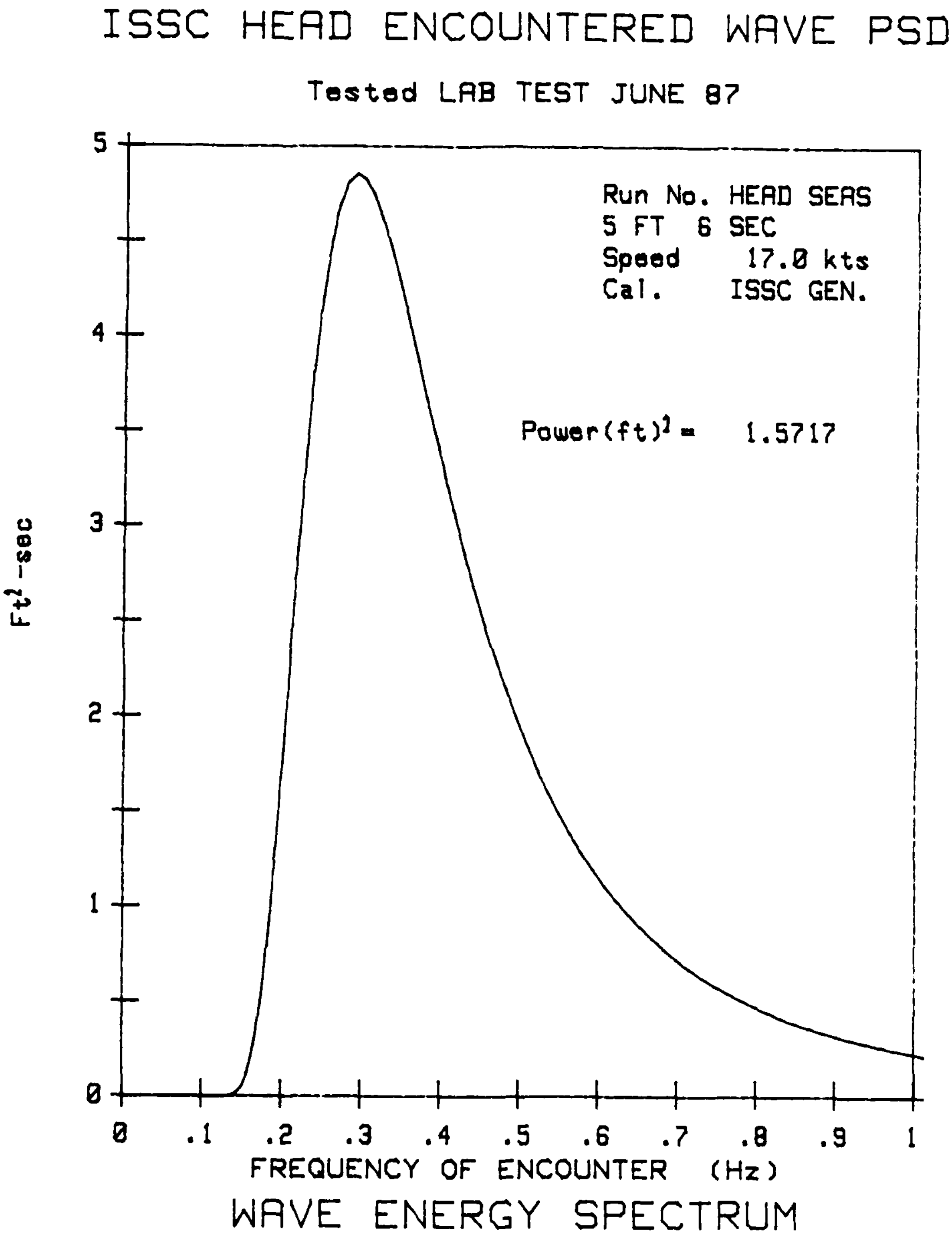


FIGURE C-44. HALCYON and PT KNOLL Wave PSD Encountered Plot, 5 Ft Head Seas

TABLE C-XLIV
HALCYON and PT KNOLL Wave PSD Encountered
5 Ft Head Seas

ISSC HEAD ENCOUNTERED WAVE PSD

Wave Energy Spectrum
Tested LAB TEST JUNE 87

Run No. HEAD SEAS, Speed 17 , SEAS 5 FT 6 SEC

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (FT SQR-SEC)
.047177	0.000000E+00
.111188	2.181130E-06
.192033	1.296844E+00
.289713	4.848584E+00
.404227	3.253699E+00
.535575	1.603203E+00
.683757	7.712685E-01
.848774	3.869880E-01
1.030625	2.050676E-01
1.229310	1.145497E-01
1.444830	6.708435E-02
1.677183	4.094896E-02
1.926371	2.591529E-02
2.192394	1.692686E-02
2.475250	1.136646E-02
2.774941	7.821462E-03
3.091466	5.500103E-03
3.424825	3.943321E-03
3.775019	2.876734E-03
4.142047	2.131788E-03
4.525909	1.602349E-03
4.926605	1.220071E-03
5.344136	9.400365E-04
5.778501	7.321698E-04
6.229700	5.759865E-04

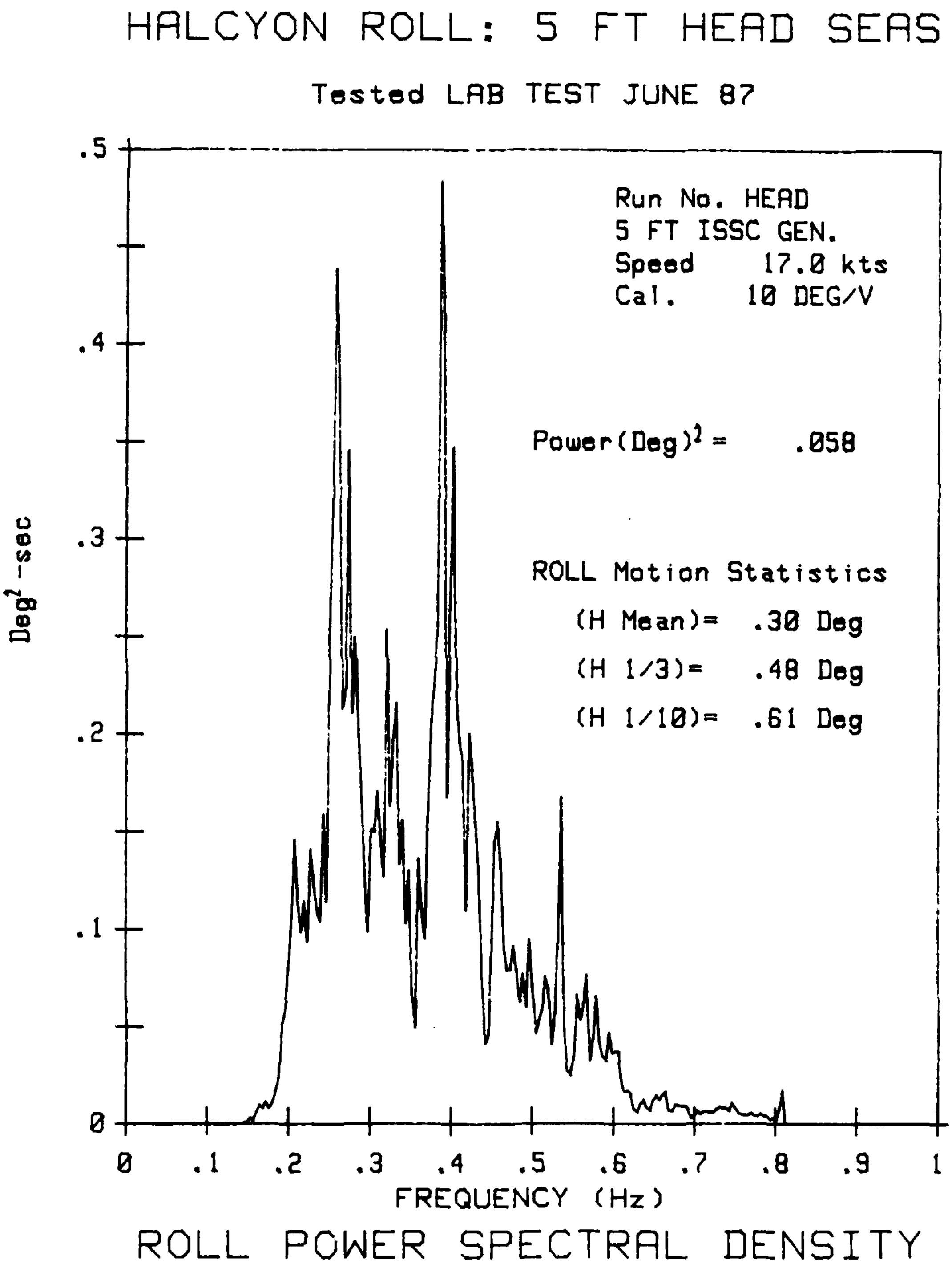


FIGURE C-45. HALCYON Roll PSD Plot, 5 Ft Head Seas

TABLE C-XLV
HALCYON Roll PSD
5 Ft Head Seas

HALCYON ROLL: 5 FT HEAD SEAS

ROLL Energy Spectrum
Tested LAB TEST JUNE 87

Run No. HEAD, Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.078125	0.000000E+00
.117188	1.367433E-06
.156250	2.104471E-03
.195313	5.865562E-02
.207031	1.459656E-01
.214844	9.841085E-02
.218750	1.144479E-01
.222656	9.318940E-02
.226563	1.412384E-01
.234375	1.099608E-01
.238281	1.038037E-01
.242188	1.589299E-01
.246094	1.136642E-01
.257813	4.384600E-01
.265625	2.126070E-01
.273438	3.452329E-01
.277344	2.101712E-01
.281250	2.495377E-01
.296875	9.859319E-02
.300781	1.512711E-01
.304688	1.501506E-01
.308594	1.707488E-01
.312500	1.477155E-01
.316406	1.266168E-01
.320313	2.537181E-01
.324219	1.629248E-01
.332031	2.159080E-01
.335938	1.329354E-01
.339844	1.561333E-01
.343750	1.025243E-01
.347656	1.300460E-01
.351563	6.899700E-02
.355469	4.910744E-02
.359375	1.365229E-01
.367188	9.517672E-02
.386719	4.833604E-01
.390625	4.240445E-01
.394531	1.674775E-01
.402344	3.470720E-01
.417969	1.094915E-01
.421875	2.007557E-01
.429688	1.550604E-01
.441406	4.134818E-02
.457031	1.555353E-01
.468750	7.886069E-02
.476563	9.166944E-02
.484375	6.247716E-02
.488281	7.694557E-02
.492188	6.009938E-02

TABLE C-XLV (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.496094	9.455764E-02
.503906	4.639793E-02
.507813	5.334535E-02
.515625	7.547701E-02
.523438	4.077273E-02
.535156	1.679127E-01
.546875	2.527714E-02
.554688	6.633763E-02
.558594	5.347572E-02
.566406	7.650563E-02
.570313	3.212412E-02
.578125	6.566142E-02
.585938	3.413467E-02
.589844	3.263814E-02
.625000	7.436425E-03
.628906	6.319133E-03
.664063	1.653272E-02
.703125	6.532858E-03
.742188	7.040580E-03
.781250	5.353632E-03
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

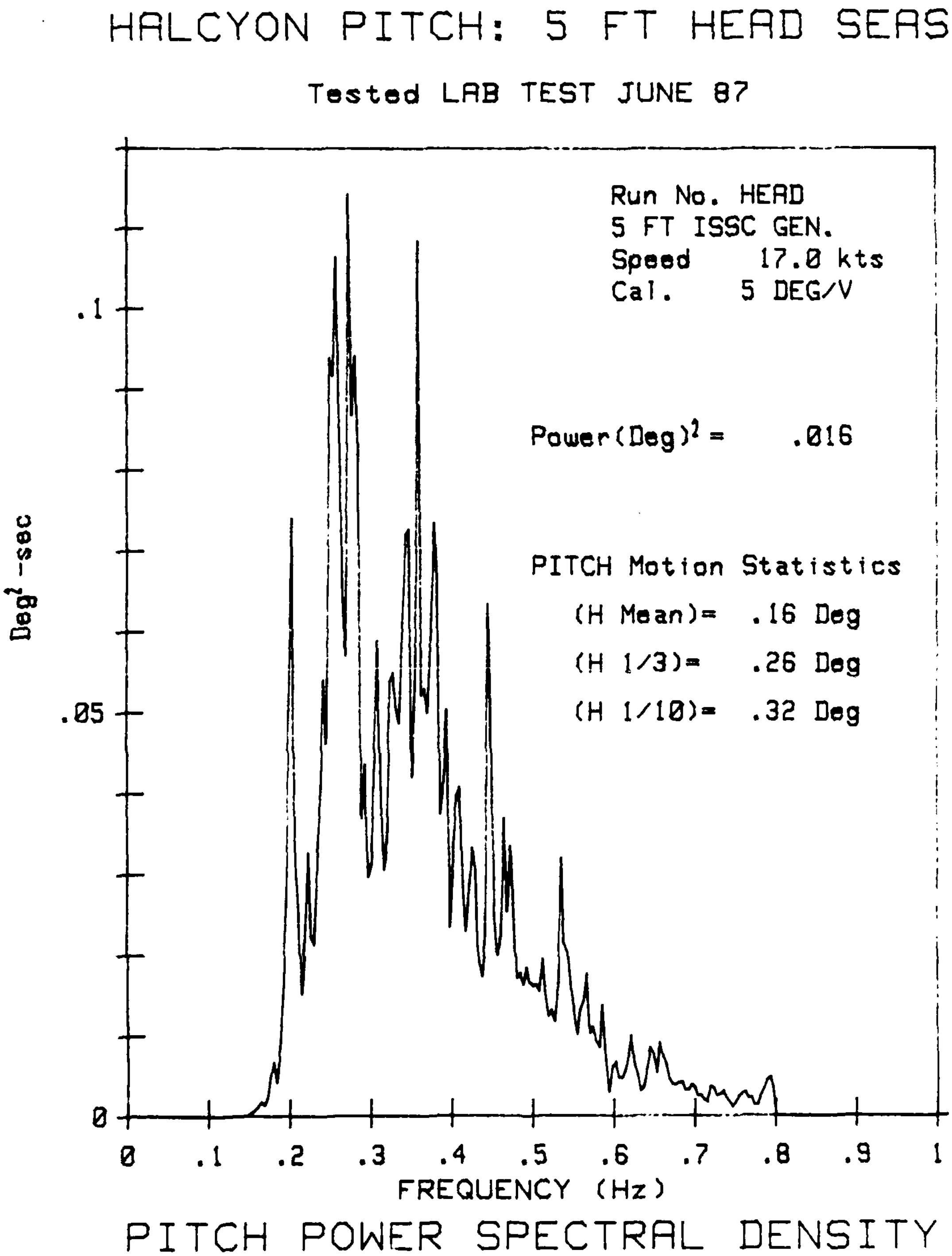


FIGURE C-46. HALCYON Pitch PSD Plot, 5 Ft Head Seas

TABLE C-XLVI
HALYCON Pitch PSD
5 Ft Head Seas

HALCYON PITCH: 5 FT HEAD SEAS

PITCH Energy Spectrum
Tested LAB TEST JUNE 87

Run No. HEAD, Speed 17 , SEAS 5 FT ISSC GEN.

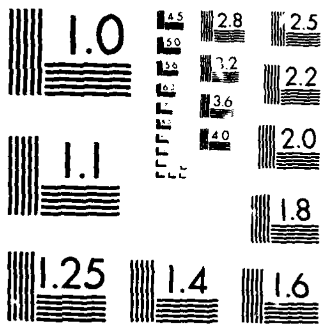
FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.078125	0.000000E+00
.117188	1.842044E-07
.156250	7.374531E-04
.179688	6.681737E-03
.195313	2.564342E-02
.203125	7.394646E-02
.214844	1.508917E-02
.222656	3.267569E-02
.230469	2.130500E-02
.234375	3.303062E-02
.242188	5.403149E-02
.246094	4.616573E-02
.250000	9.369708E-02
.253906	9.151328E-02
.257813	1.062753E-01
.269531	5.691773E-02
.273438	1.142070E-01
.277344	8.662179E-02
.281250	9.398422E-02
.289063	3.685053E-02
.292969	4.353801E-02
.296875	2.955662E-02
.308594	5.881848E-02
.312500	4.259522E-02
.316406	3.046945E-02
.328125	5.485617E-02
.335938	4.860102E-02
.347656	7.252484E-02
.351563	4.197940E-02
.359375	1.083831E-01
.363281	5.205698E-02
.367188	5.284452E-02
.371094	4.991910E-02
.378906	7.335462E-02
.386719	3.731577E-02
.390625	4.180549E-02
.394531	5.026471E-02
.398438	2.333332E-02
.410156	4.073067E-02
.4[illegible]969	2.282804E-02
.425781	3.322933E-02
.429688	3.027075E-02
.437500	1.724257E-02
.445313	6.335798E-02
.457031	1.987318E-02
.464844	3.695058E-02
.468750	2.530177E-02
.472656	3.345001E-02
.480469	1.710216E-02

TABLE C-XLVI (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.484375	1.761793E-02
.488281	1.617389E-02
.492188	1.839833E-02
.500000	1.613643E-02
.503906	1.626078E-02
.507813	1.547965E-02
.511719	1.948894E-02
.519531	1.238525E-02
.523438	1.310173E-02
.535156	3.198875E-02
.546875	1.628901E-02
.554688	1.009204E-02
.566406	1.760602E-02
.570313	1.025011E-02
.585938	1.378069E-02
.593750	2.993998E-03
.621094	9.988138E-03
.625000	6.370560E-03
.632813	3.086247E-03
.664063	6.403030E-03
.703125	2.532510E-03
.742188	1.761495E-03
.781250	2.561522E-03
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

AD-A190 995 TECHNICAL EVALUATION OF THE 60 FOOT SMALL WATERPLANE AREA TWIN HULL (SWAT..(U) COAST GUARD WASHINGTON DC OFFICE OF RESEARCH AND DEVELOPMENT.. T J COE AUG 87 3/3

UNCLASSIFIED USCG-D-08-88 F/G 13/10 NL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1.4
1.6

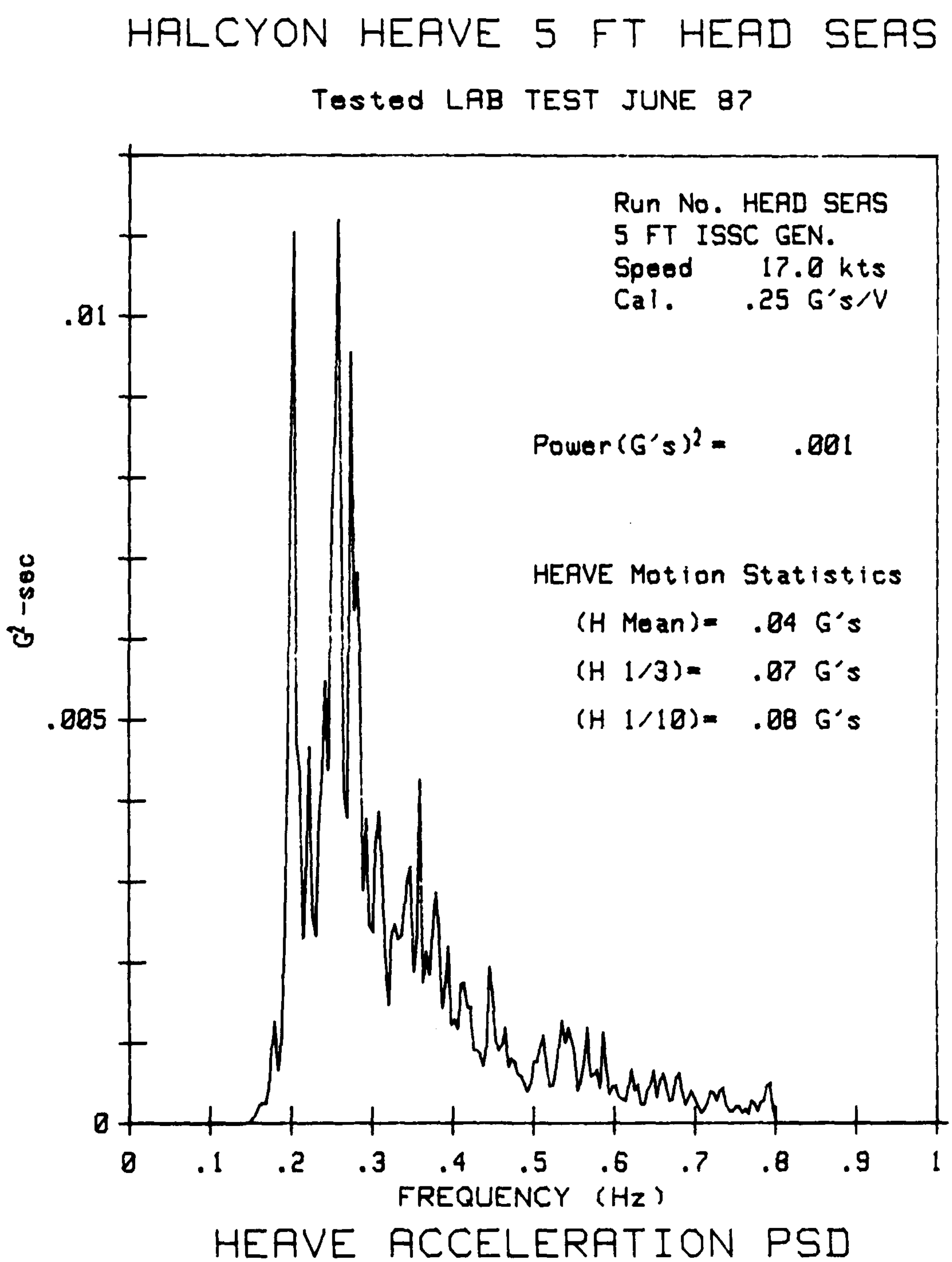

FIGURE C-47. HALCYON Heave PSD Plot, 5 Ft Head Seas

TABLE C-XLVII
HALCYON Heave PSD
5 Ft Head Seas

HALCYON HEAVE 5 FT HEAD SEAS

HEAVE Energy Spectrum
Tested LAB TEST JUNE 87

Run No. HEAD SEAS, Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.039063	0.000000E+00
.078125	0.000000E+00
.117188	3.837732E-09
.156250	1.264653E-04
.179688	1.257871E-03
.183594	6.576601E-04
.195313	4.214123E-03
.203125	1.103526E-02
.214844	2.294922E-03
.222656	4.664719E-03
.230469	2.323177E-03
.234375	3.746541E-03
.242188	5.482848E-03
.246094	4.373540E-03
.257813	1.119268E-02
.269531	3.791956E-03
.273438	9.549464E-03
.277344	6.351283E-03
.281250	6.817858E-03
.289063	2.879735E-03
.292969	3.772311E-03
.300781	2.378531E-03
.308594	3.864932E-03
.312500	3.164394E-03
.320313	1.465347E-03
.328125	2.461698E-03
.332031	2.279799E-03
.347656	3.182484E-03
.351563	1.873884E-03
.359375	4.261963E-03
.363281	1.741907E-03
.367188	2.126589E-03
.371094	1.845918E-03
.378906	2.865731E-03
.386719	1.428666E-03
.390625	1.700346E-03
.394531	2.190553E-03
.398438	1.219666E-03
.402344	1.275921E-03
.414063	1.742939E-03
.417969	1.429502E-03
.421875	1.438717E-03
.429688	9.045380E-04
.437500	7.121142E-04
.445313	1.943311E-03
.457031	9.031785E-04
.468750	6.968687E-04
.507813	9.589099E-04
.535156	1.270162E-03
.546875	1.029614E-03

TABLE C-XLVII (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.554688	3.998550E-04
.566406	1.190638E-03
.570313	5.836060E-04
.585938	1.129758E-03
.625000	4.126503E-04
.664063	4.703509E-04
.703125	2.160362E-04
.742188	1.537499E-04
.781250	2.575158E-04
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

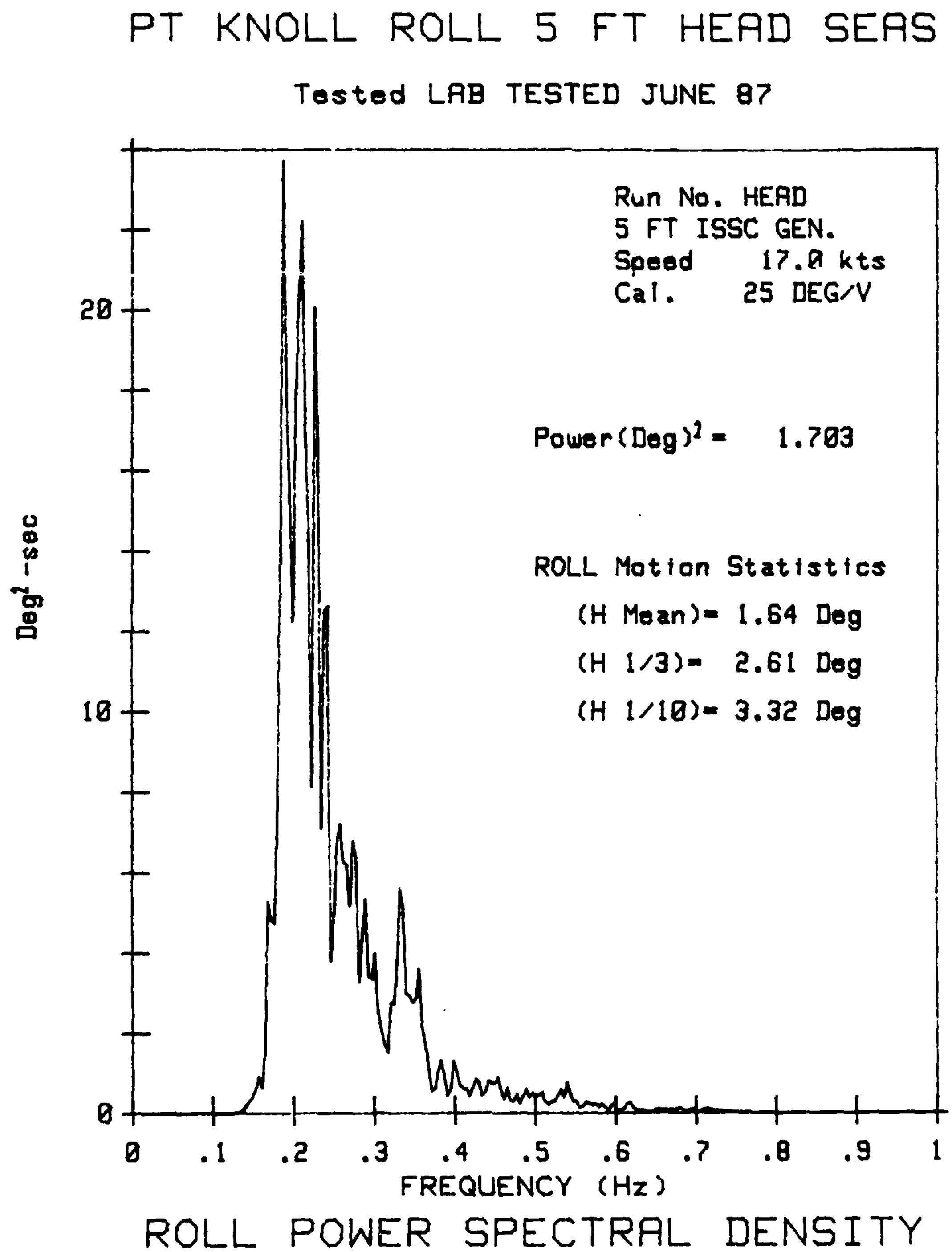

FIGURE C-48. PT KNOLL Roll PSD Plot, 5 Ft Head Seas

TABLE C-XLVIII
PT KNOLL Roll PSD
5 Ft Head Seas

PT KNOLL ROLL 5 FT HEAD SEAS

ROLL Energy Spectrum
Tested LAB TESTED JUNE 87

Run No. HEAD, Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.078125	7.876089E-15
.117188	3.149218E-04
.156250	9.239930E-01
.167969	5.272224E+00
.175781	4.736756E+00
.187500	2.369962E+01
.195313	1.534457E+01
.199219	1.223049E+01
.210938	2.220992E+01
.222656	8.107599E+00
.226563	2.004496E+01
.234375	7.082771E+00
.242188	1.259679E+01
.246094	3.768224E+00
.257813	7.191404E+00
.269531	5.138204E+00
.273438	6.758164E+00
.281250	3.271822E+00
.289063	5.329263E+00
.296875	3.344437E+00
.300781	3.965622E+00
.312500	1.707164E+00
.316406	1.516671E+00
.320313	2.743799E+00
.324219	2.728038E+00
.332031	5.607193E+00
.347656	2.748832E+00
.351563	2.842698E+00
.355469	3.571888E+00
.371094	5.566724E-01
.390625	4.291722E-01
.429688	7.574790E-01
.468750	3.023612E-01
.507813	5.310010E-01
.546875	3.032613E-01
.585938	1.599364E-01
.625000	8.191425E-02
.664063	6.062069E-02
.703125	1.861718E-02
.742188	3.402441E-02
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

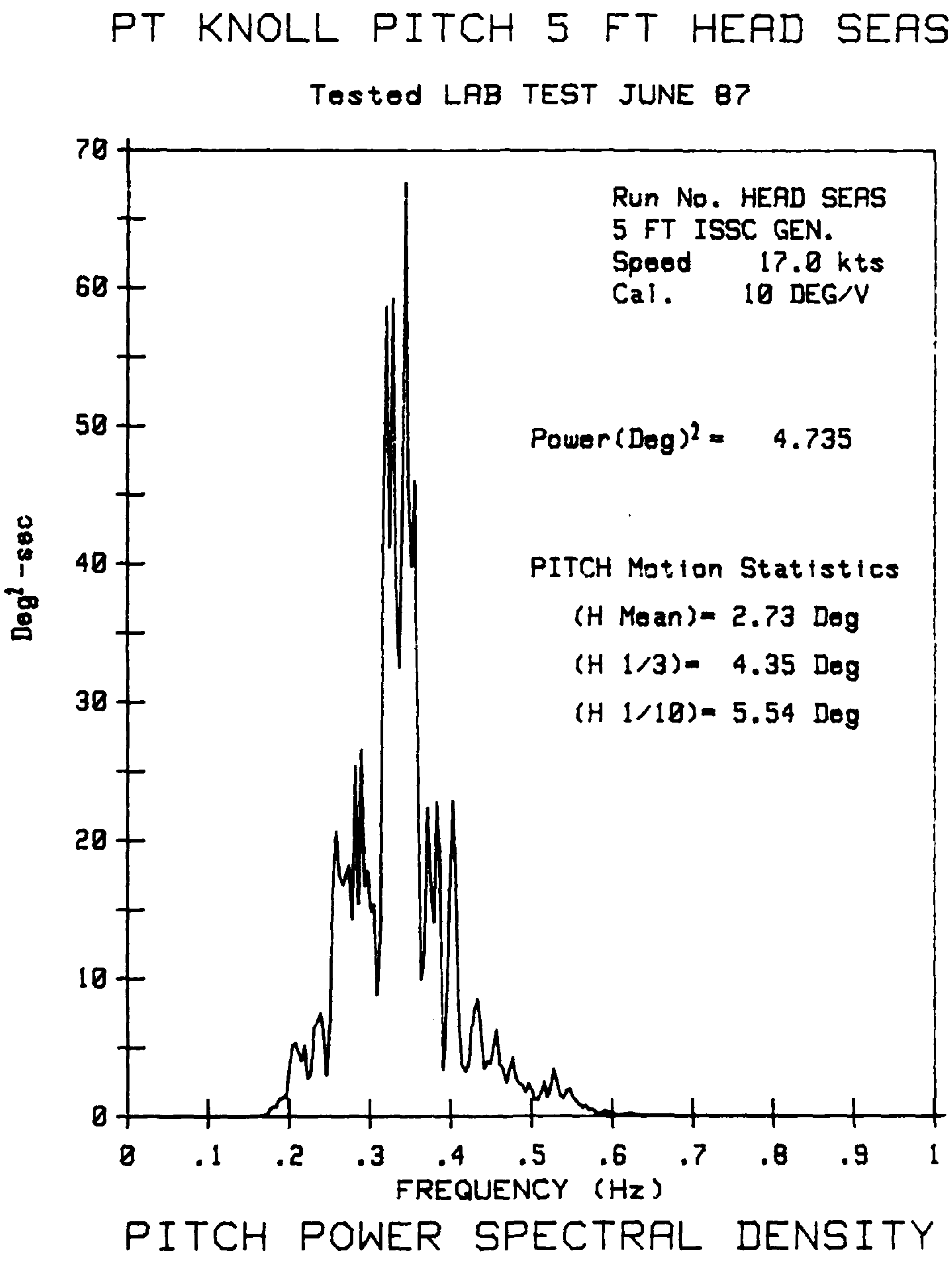

FIGURE C-49. PT KNOLL Pitch PSD Plot, 5 Ft Head Seas

TABLE C-XLIX
PT KNOLL Pitch PSD
5 Ft Head Seas

PT KNOLL PITCH 5 FT HEAD SEAS

PITCH Energy Spectrum
Tested LAB TEST JUNE 87

Run No. HEAD SEAS, Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.078125	2.450159E-16
.117188	1.772034E-05
.156250	4.543910E-02
.195313	1.384832E+00
.207031	5.295919E+00
.234375	6.945704E+00
.238281	7.453843E+00
.246094	2.984068E+00
.257813	2.066864E+01
.265625	1.676667E+01
.273438	1.816068E+01
.277344	1.429302E+01
.281250	2.537990E+01
.285156	1.539727E+01
.289063	2.653963E+01
.292969	1.666913E+01
.296875	1.774642E+01
.300781	1.486692E+01
.304688	1.531276E+01
.308594	8.800266E+00
.312500	1.359914E+01
.320313	5.860633E+01
.324219	4.112331E+01
.328125	5.915718E+01
.335938	3.246738E+01
.343750	6.758316E+01
.351563	3.979840E+01
.355469	4.595854E+01
.363281	9.902628E+00
.371094	2.234968E+01
.378906	1.402805E+01
.382813	2.274585E+01
.390625	3.368329E+00
.402344	2.282273E+01
.417969	3.273009E+00
.429688	7.856570E+00
.433594	8.510716E+00
.441406	3.448471E+00
.468750	2.440741E+00
.507813	1.226743E+00
.546875	1.951260E+00
.585938	2.300154E-01
.625000	1.382209E-01
.664063	5.335287E-02
.703125	1.480189E-02
.742188	1.468308E-02
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00

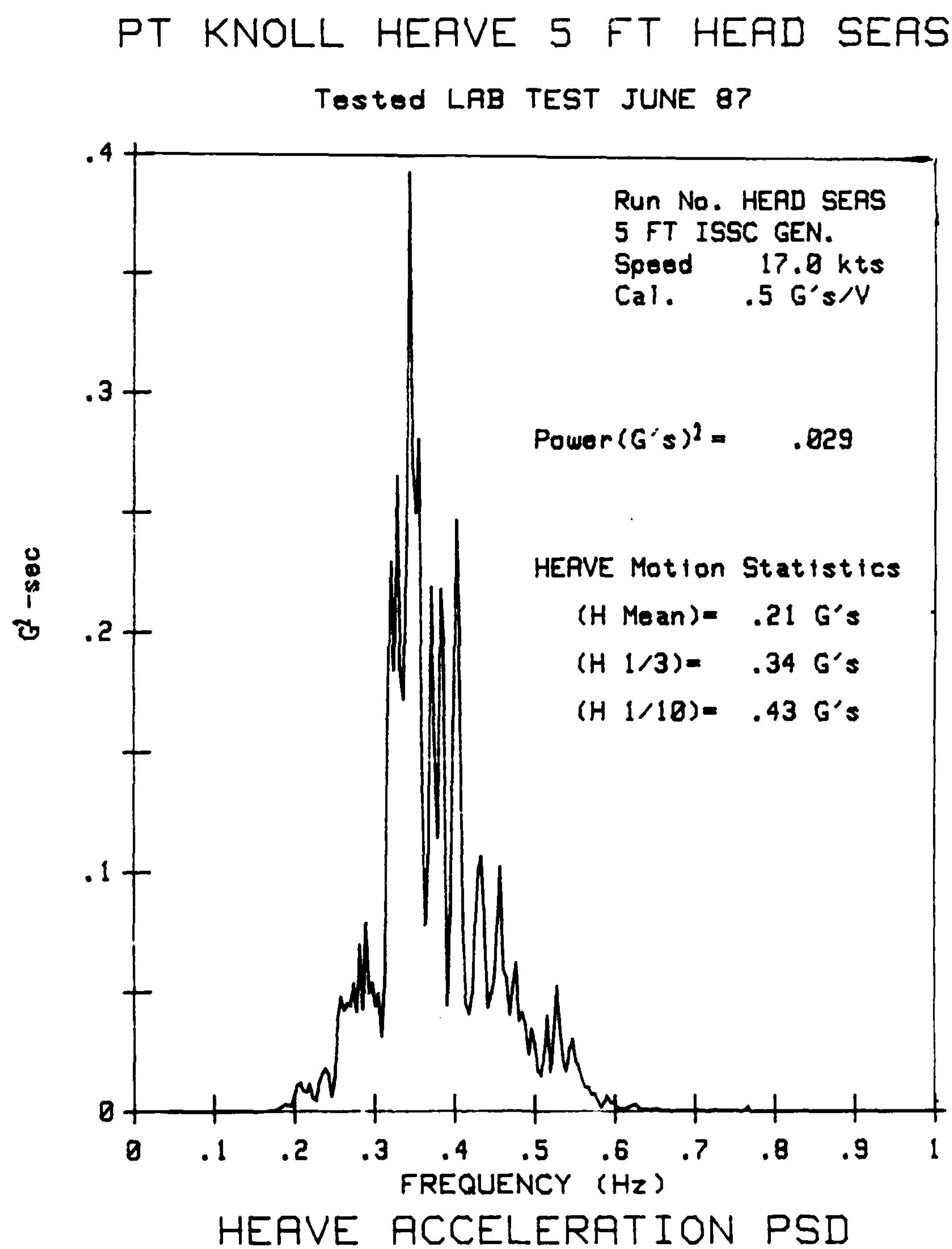

FIGURE C-50. PT KNOLL Heave PSD Plot, 5 Ft Head Seas

TABLE C-L
PT KNOLL Heave PSD
5 Ft Head Seas

PT KNOLL HEAVE 5 FT HEAD SEAS

HEAVE Energy Spectrum
Tested LAB TEST JUNE 87

Run No. HEAD SEAS, Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (FT SQR-SEC)
.039063	0.000000E+00
.078125	1.869221E-21
.117188	6.962055E-09
.156250	6.755031E-05
.195313	2.594162E-03
.234375	1.572966E-02
.257813	4.779532E-02
.261719	4.218234E-02
.265625	4.487552E-02
.269531	4.425282E-02
.273438	5.340921E-02
.277344	4.180862E-02
.281250	6.945866E-02
.285156	4.282362E-02
.289063	7.869947E-02
.292969	4.936979E-02
.296875	5.341295E-02
.300781	4.397748E-02
.304688	4.908193E-02
.312500	5.699938E-02
.320313	2.289219E-01
.324219	1.834405E-01
.328125	2.647882E-01
.335938	1.715327E-01
.343750	3.921245E-01
.351563	2.491734E-01
.355469	2.799720E-01
.363281	7.755985E-02
.371094	2.184884E-01
.378906	1.139097E-01
.382813	2.176617E-01
.390625	4.407358E-02
.402344	2.463748E-01
.417969	4.044057E-02
.429688	1.010225E-01
.433594	1.066519E-01
.441406	4.312481E-02
.457031	1.021118E-01
.468750	4.021855E-02
.476563	6.185497E-02
.480469	3.766538E-02
.484375	4.097918E-02
.507813	1.508481E-02
.515625	4.029938E-02
.519531	1.660838E-02
.527344	5.233559E-02
.539063	1.663963E-02
.546875	3.016217E-02
.585938	3.753863E-03
.625000	2.973727E-03

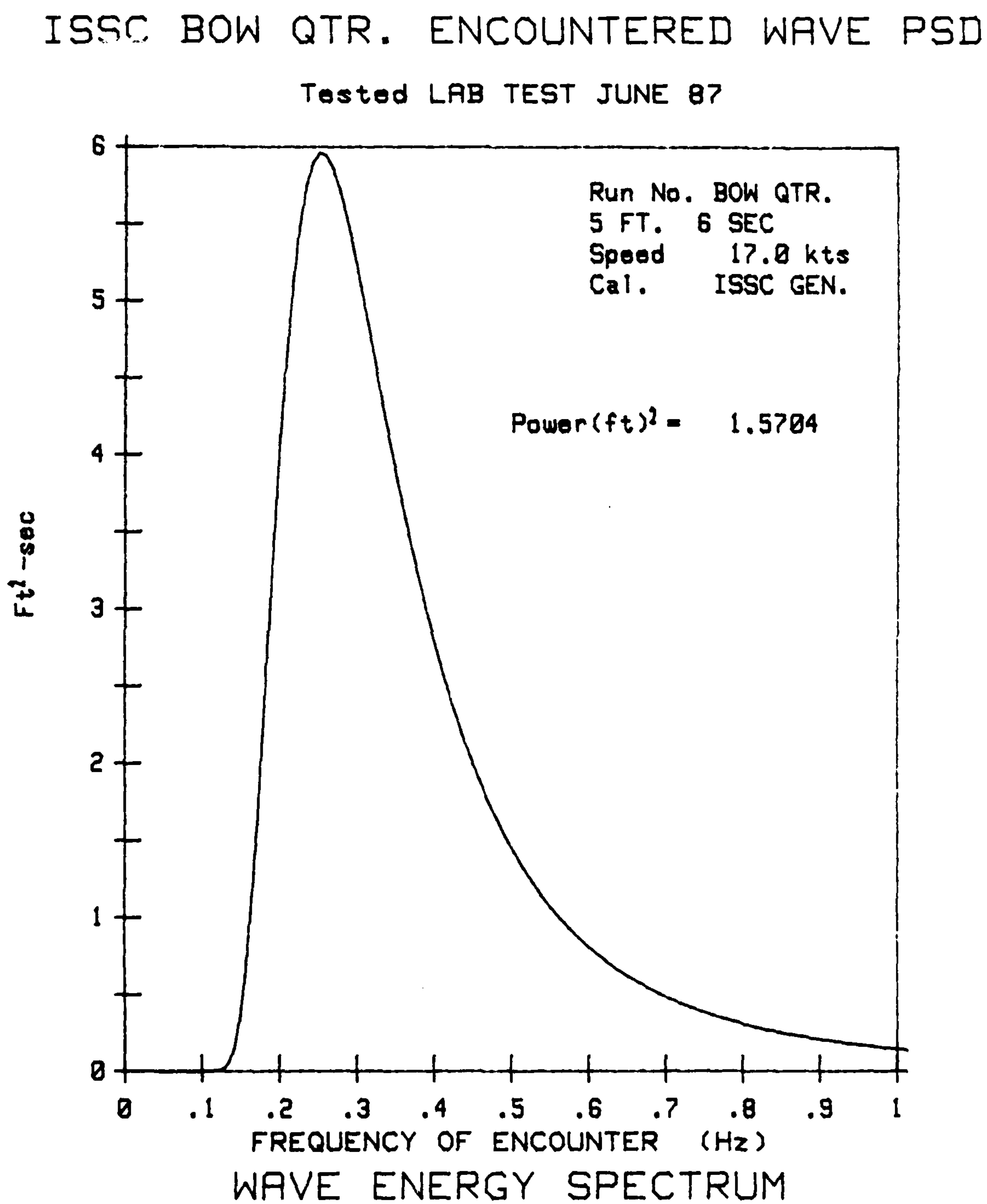

FIGURE C-51. HALCYON and PT KNOLL Wave PSD Encountered Plot
5 Ft Bow Quarter Seas

TABLE C-LI
HALCYON and PT KNOLL Wave PSD Encountered
5 Ft Bow Quarter Seas

ISSC BOW QTR. ENCOUNTERED WAVE PSD

Wave Energy Spectrum
Tested LAB TEST JUNE 87

Run No. BOW QTR., Speed 17 , SEAS 5 FT. 6 SEC

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (FT SQR-SEC)
.044712	0.000000E+00
.101327	2.524902E-06
.169845	1.554433E+00
.250268	5.955703E+00
.342594	4.069897E+00
.446823	2.033666E+00
.562957	9.893128E-01
.690993	5.009140E-01
.830934	2.674426E-01
.982778	1.503430E-01
1.146526	8.852494E-02
1.322177	5.429044E-02
1.509732	3.449962E-02
1.709191	2.261520E-02
1.920553	1.523487E-02
2.143819	1.051339E-02
2.378988	7.412102E-03
2.626061	5.326489E-03
2.885038	3.893985E-03
3.155918	2.891172E-03
3.438702	2.176967E-03
3.733390	1.660286E-03
4.039981	1.281124E-03
4.358476	9.992141E-04
4.688874	7.870748E-04

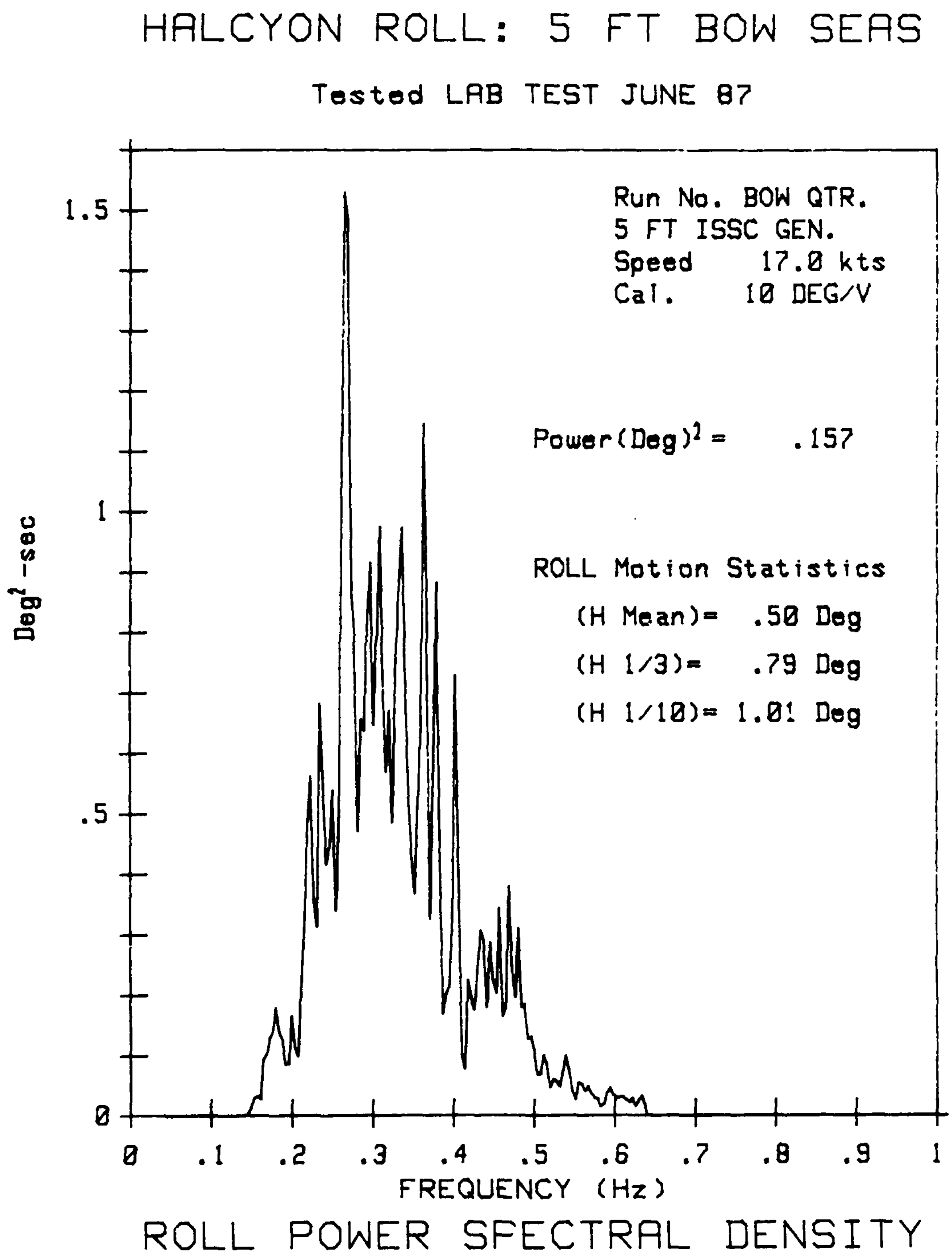

FIGURE C-52. HALCYON Roll PSD Plot, 5 Ft Bow Seas

TABLE C-LII
HALCYON Roll PSD
5 Ft Bow Seas

HALCYON

ROLL Energy Spectrum
Tested

Run No. , Speed 17 , SEAS BOW QTR , 5 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.078125	0.000000E+00
.117188	2.440982E-05
.156250	3.271752E-02
.179688	1.784144E-01
.191406	8.486977E-02
.195313	8.645400E-02
.199219	1.655629E-01
.222656	5.622299E-01
.230469	3.125987E-01
.234375	6.823734E-01
.242188	4.155363E-01
.250000	5.387687E-01
.253906	3.388724E-01
.265625	1.529019E+00
.273438	8.742210E-01
.281250	4.703974E-01
.285156	6.563709E-01
.289063	6.367699E-01
.296875	9.150444E-01
.300781	6.458797E-01
.308594	9.749889E-01
.312500	7.248128E-01
.316406	5.679041E-01
.320313	6.707598E-01
.324219	4.847514E-01
.335938	9.728848E-01
.351563	3.655191E-01
.363281	1.144538E+00
.371094	3.249961E-01
.378906	8.831585E-01
.386719	1.676494E-01
.390625	2.023897E-01
.402344	7.295088E-01
.414063	7.699702E-02
.417969	2.246010E-01
.425781	1.748609E-01
.429688	2.410419E-01
.433594	3.072608E-01
.441406	1.797231E-01
.445313	2.869806E-01
.453125	2.024790E-01
.457031	3.443352E-01
.460938	1.639186E-01
.468750	3.801723E-01
.476563	1.955146E-01
.480469	3.104092E-01
.484375	1.791176E-01
.488281	1.835149E-01
.503906	6.876998E-02

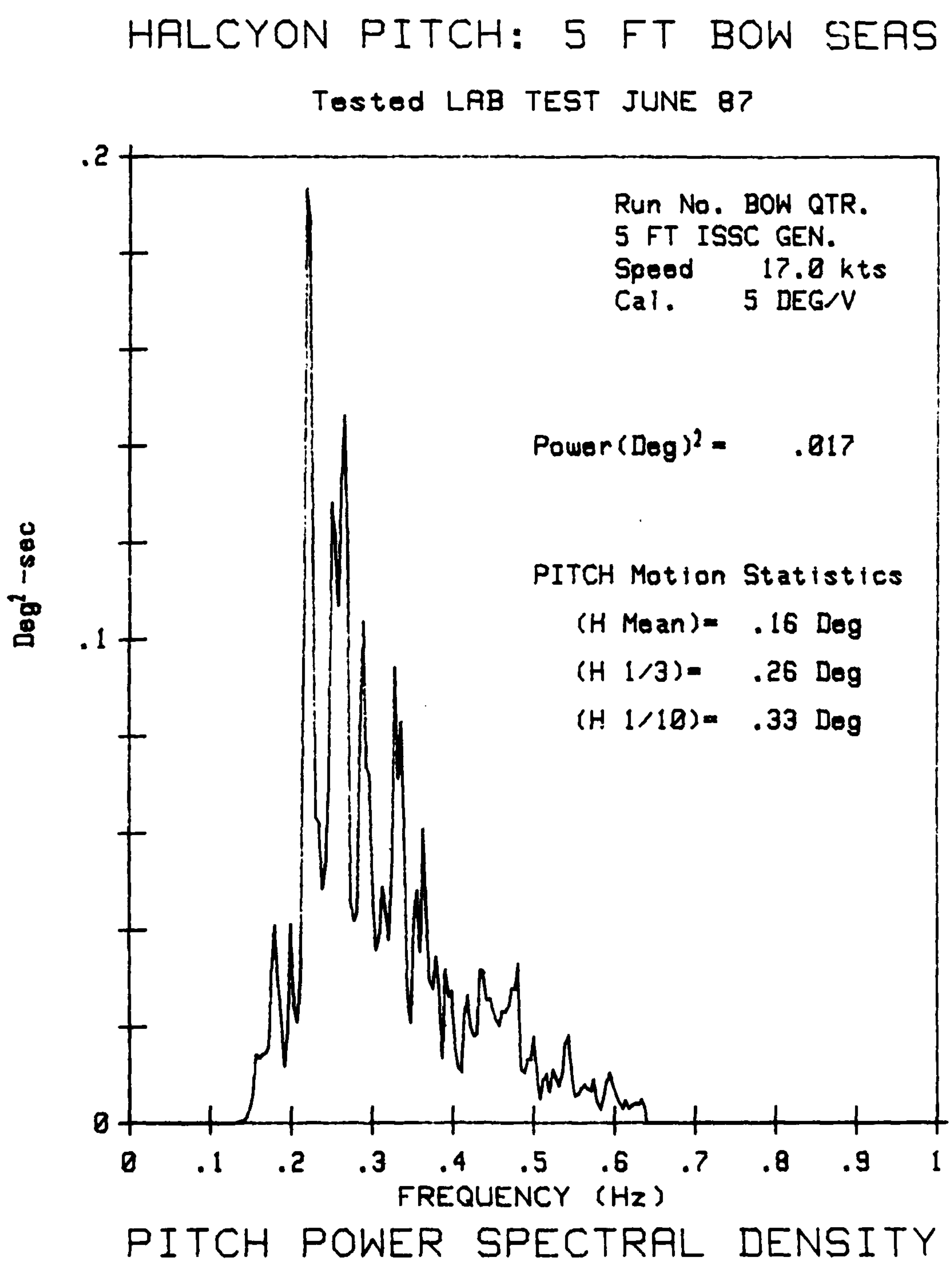

FIGURE C-53. HALCYON Pitch PSD Plot, 5 Ft Bow Seas

TABLE C-LIII
HALCYON Pitch PSD
5 Ft Bow Seas

HALCYON PITCH: 5 FT BOW SEAS

PITCH Energy Spectrum
Tested LAB TEST JUNE 87

Run No. BOW QTR., Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.078125	0.000000E+00
.117188	5.957661E-06
.156250	1.426188E-02
.179688	4.096585E-02
.191406	1.164662E-02
.195313	1.923104E-02
.199219	4.118611E-02
.207031	2.088253E-02
.218750	1.932902E-01
.234375	6.188250E-02
.238281	4.839736E-02
.250000	1.282862E-01
.257813	1.069239E-01
.265625	1.462002E-01
.273438	4.597572E-02
.277344	4.181748E-02
.289063	1.036804E-01
.304688	3.577986E-02
.312500	4.873384E-02
.320313	3.789663E-02
.328125	9.422324E-02
.332031	7.114826E-02
.335938	8.291158E-02
.347656	2.077490E-02
.351563	4.255107E-02
.355469	4.806373E-02
.359375	3.540228E-02
.363281	6.082282E-02
.375000	2.773483E-02
.378906	3.448920E-02
.386719	1.341304E-02
.390625	3.180377E-02
.394531	2.626389E-02
.398438	2.714521E-02
.410156	1.059517E-02
.417969	2.639479E-02
.429688	1.845313E-02
.433594	3.170778E-02
.441406	2.551426E-02
.445313	2.562499E-02
.457031	2.022997E-02
.468750	2.419098E-02
.472656	2.796873E-02
.476563	2.778598E-02
.480469	3.296832E-02
.488281	1.047681E-02
.507813	5.056023E-03
.546875	1.057146E-02
.585938	5.202648E-03

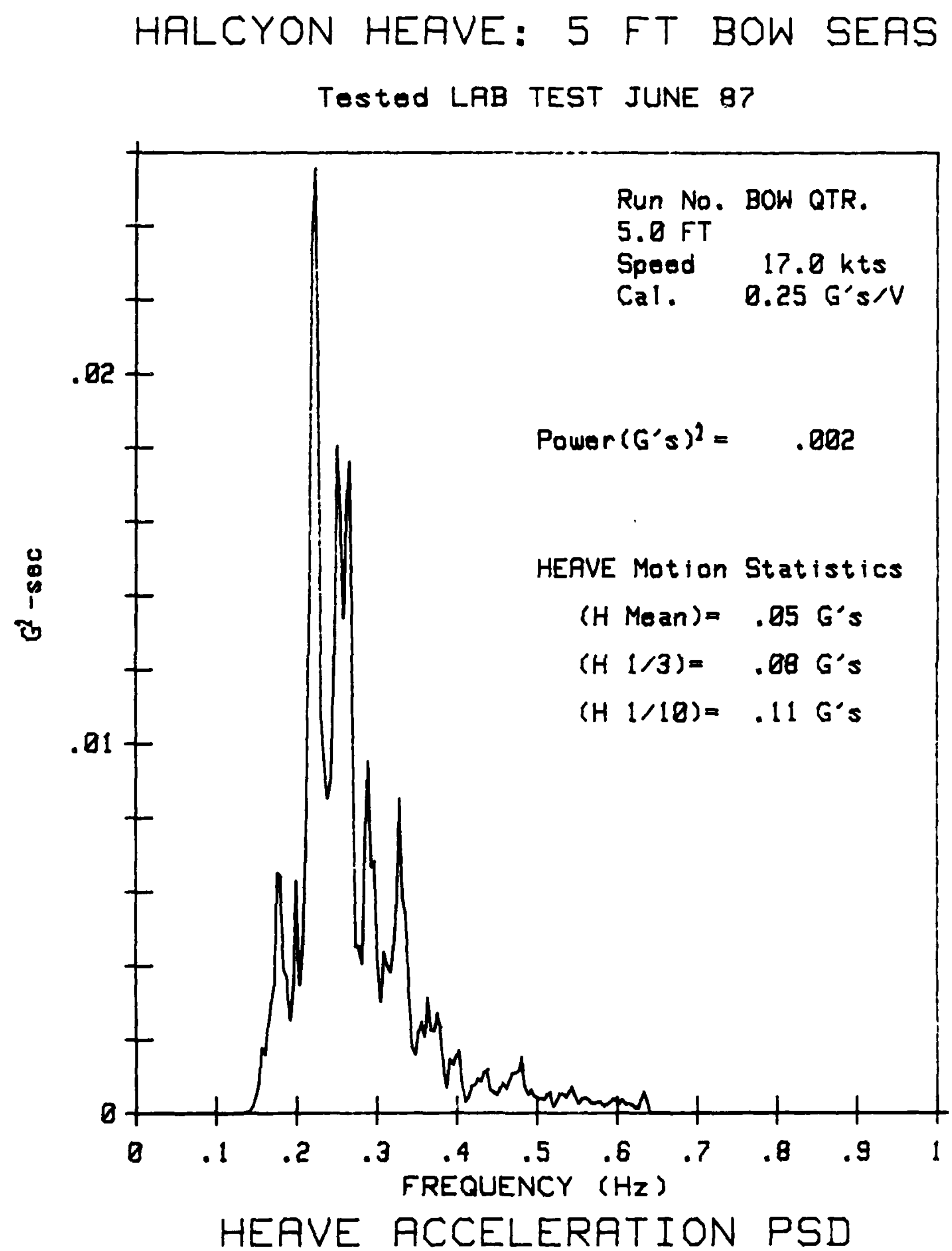

FIGURE C-54. HALCYON Heave PSD Plot, 5 Ft Bow Seas

TABLE C-LIV
HALCYON Heave PSD
5 Ft Bow Seas

HALCYON HEAVE: 5 FT BOW SEAS

HEAVE Energy Spectrum
Tested LAB TEST JUNE 87

Run No. BOW QTR., Speed 17 , SEAS 5.0 FT

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.039063	0.000000E+00
.078125	1.197232E-18
.117188	2.472075E-07
.156250	1.789352E-03
.175781	6.508603E-03
.191406	2.511853E-03
.195313	3.298543E-03
.199219	6.294729E-03
.203125	3.460532E-03
.222656	2.556061E-02
.234375	9.493137E-03
.238281	8.508828E-03
.250000	1.803214E-02
.257813	1.337097E-02
.265625	1.760441E-02
.273438	4.496428E-03
.277344	4.508123E-03
.281250	4.048594E-03
.289063	9.522287E-03
.292969	6.660947E-03
.296875	6.788677E-03
.304688	3.009939E-03
.308594	4.372323E-03
.312500	4.007002E-03
.316406	3.828346E-03
.328125	8.528739E-03
.347656	1.587327E-03
.351563	2.202370E-03
.363281	3.136139E-03
.375000	2.710081E-03
.386719	7.007561E-04
.390625	1.453706E-03
.429688	8.753067E-04
.468750	1.081846E-03
.507813	3.709036E-04
.546875	4.718516E-04
.585938	2.394132E-04
.625000	1.431451E-04
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

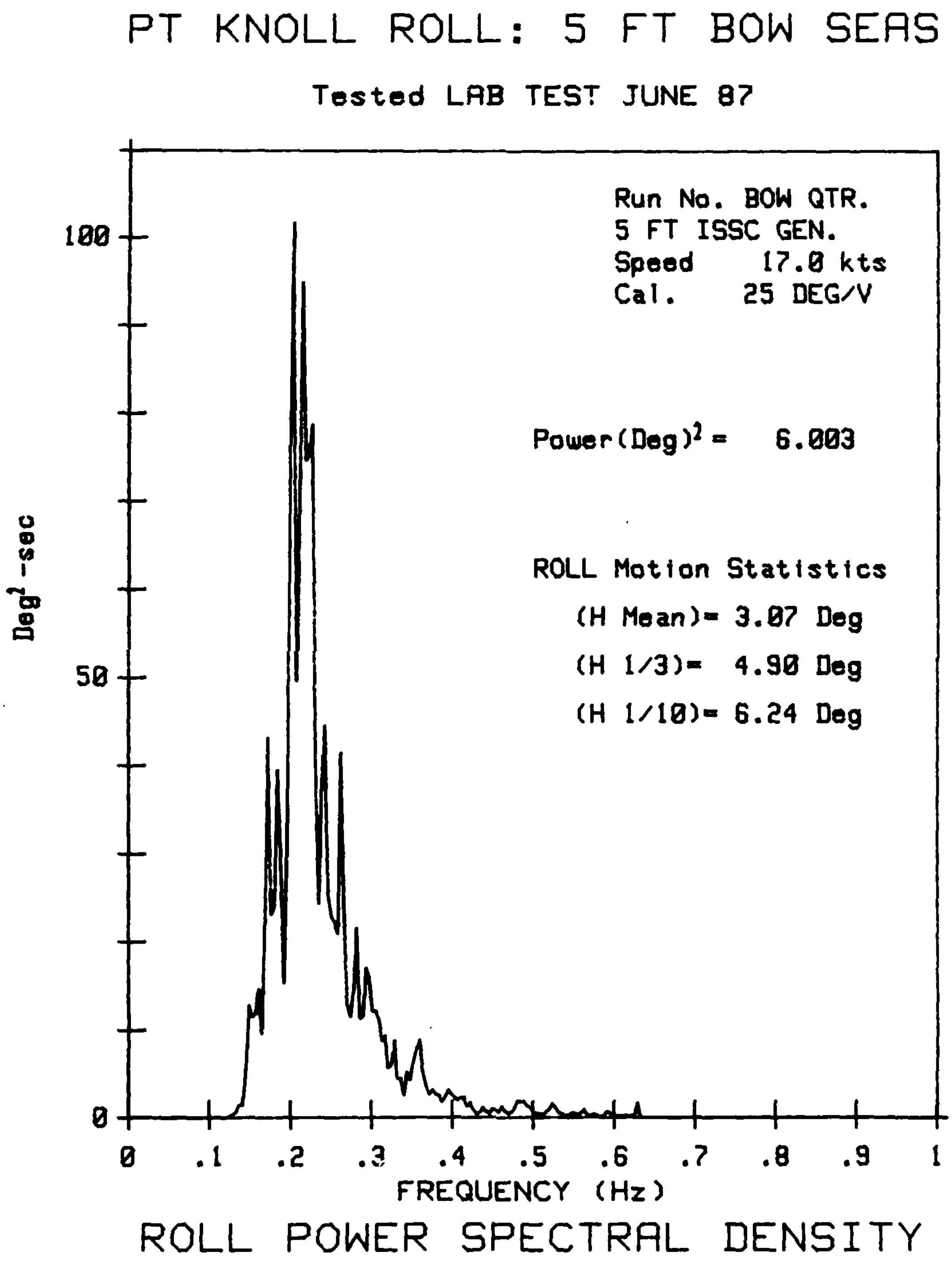

FIGURE C-55. PT KNOLL Roll PSD Plot, 5 Ft Bow Seas

TABLE C-LV
PT KNOLL Roll PSD
5 Ft Bow Seas

PT KNOLL ROLL: 5 FT BOW SEAS

ROLL Energy Spectrum
Tested LAB TEST JUNE 87

Run No. BOW QTR., Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.078125	3.161696E-11
.117188	3.091411E-02
.148438	1.279064E+01
.152344	1.141185E+01
.156250	1.180889E+01
.160156	1.459867E+01
.171875	4.316060E+01
.175781	2.302115E+01
.183594	3.948260E+01
.191406	1.525219E+01
.195313	3.189590E+01
.203125	1.016797E+02
.207031	4.955204E+01
.214844	9.481616E+01
.218750	7.449928E+01
.226563	7.857645E+01
.234375	2.422748E+01
.242188	4.448571E+01
.257813	2.083934E+01
.261719	4.146049E+01
.273438	1.139611E+01
.281250	2.143166E+01
.285156	1.118766E+01
.292969	1.700952E+01
.300781	1.204452E+01
.304688	1.207030E+01
.312500	8.696207E+00
.320313	5.601453E+00
.351563	6.408237E+00
.390625	2.325373E+00
.429688	3.858673E-01
.468750	4.773930E-01
.507813	4.050580E-01
.546875	5.127797E-01
.585938	2.017787E-01
.625000	3.469387E-01
.632813	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

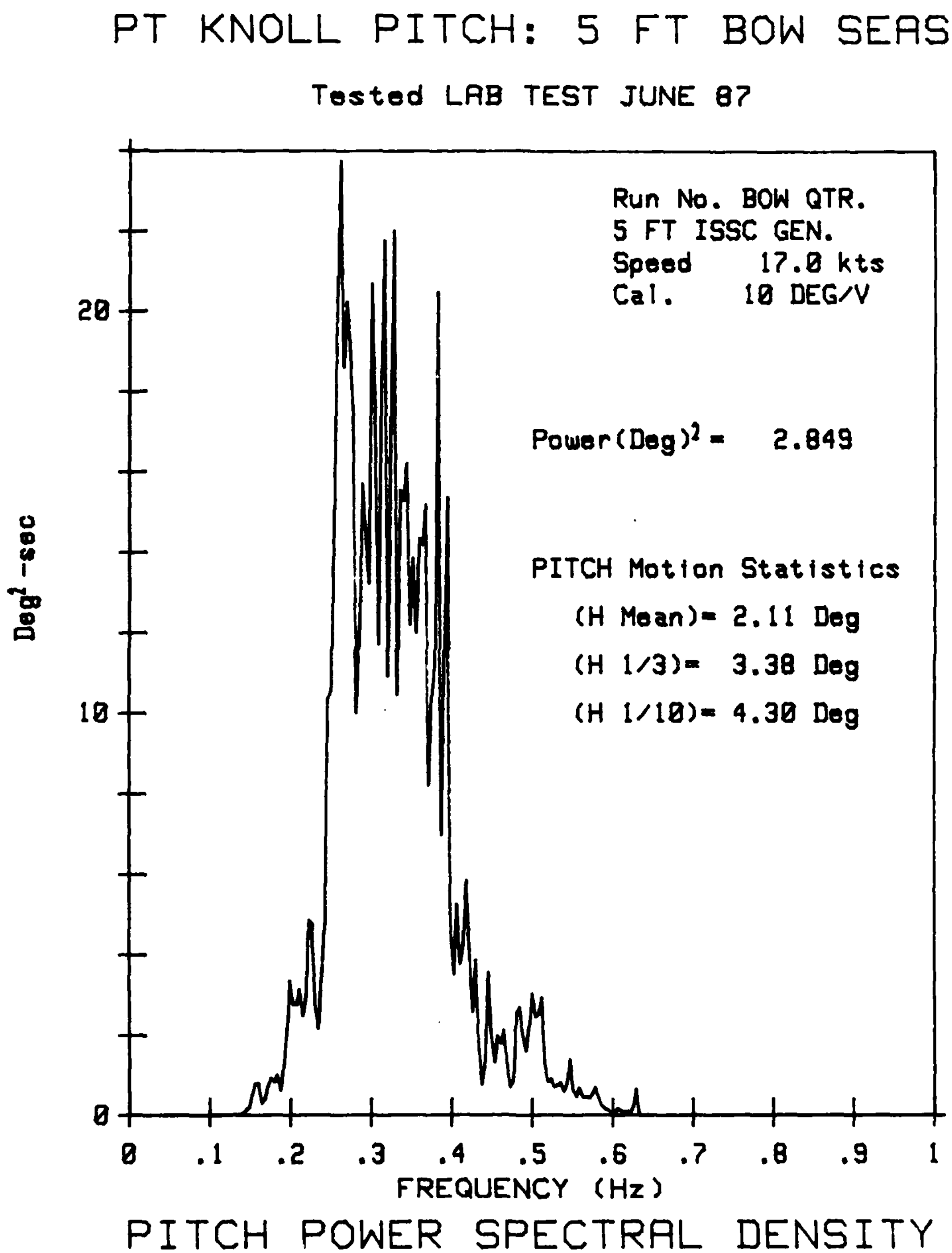

FIGURE C-56. PT KNOLL Pitch PSD Plot, 5 Ft Bow Seas

TABLE C-LVI
PT KNOLL Pitch PSD
5 Ft Bow Seas

PT KNOLL PITCH: 5 FT BOW SEAS

PITCH Energy Spectrum
Tested LAB TEST JUNE 87

Run No. BOW QTR., Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.078125	6.826066E-13
.117188	1.318086E-03
.156250	7.961913E-01
.195313	2.085960E+00
.199219	3.352568E+00
.207031	2.753320E+00
.210938	3.127704E+00
.214844	2.484822E+00
.222656	4.854567E+00
.234375	2.159342E+00
.261719	2.374033E+01
.265625	1.858067E+01
.269531	2.021353E+01
.273438	1.920141E+01
.281250	9.987073E+00
.289063	1.568938E+01
.296875	1.320082E+01
.300781	2.067725E+01
.308594	1.168933E+01
.312500	1.831183E+01
.316406	2.174735E+01
.320313	1.090874E+01
.328125	2.200703E+01
.332031	1.044303E+01
.335938	1.553416E+01
.339844	1.527333E+01
.343750	1.619840E+01
.347656	1.217928E+01
.351563	1.384727E+01
.355469	1.199767E+01
.359375	1.434274E+01
.363281	1.417788E+01
.367188	1.517207E+01
.371094	8.194020E+00
.382813	2.046285E+01
.386719	6.967533E+00
.390625	1.143556E+01
.394531	1.536895E+01
.402344	3.494183E+00
.406250	5.258167E+00
.410156	3.752323E+00
.417969	5.844827E+00
.425781	2.585960E+00
.429688	3.871848E+00
.437500	7.553003E-01
.445313	3.569842E+00
.453125	1.319468E+00
.468750	1.253192E+00
.484375	2.691480E+00

TABLE C-LVI (cont'd)

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.500000	3.038105E+00
.503906	2.459391E+00
.507813	2.513665E+00
.511719	2.930294E+00
.519531	8.392224E-01
.546875	1.386904E+00
.585938	2.311537E-01
.625000	2.092295E-01
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

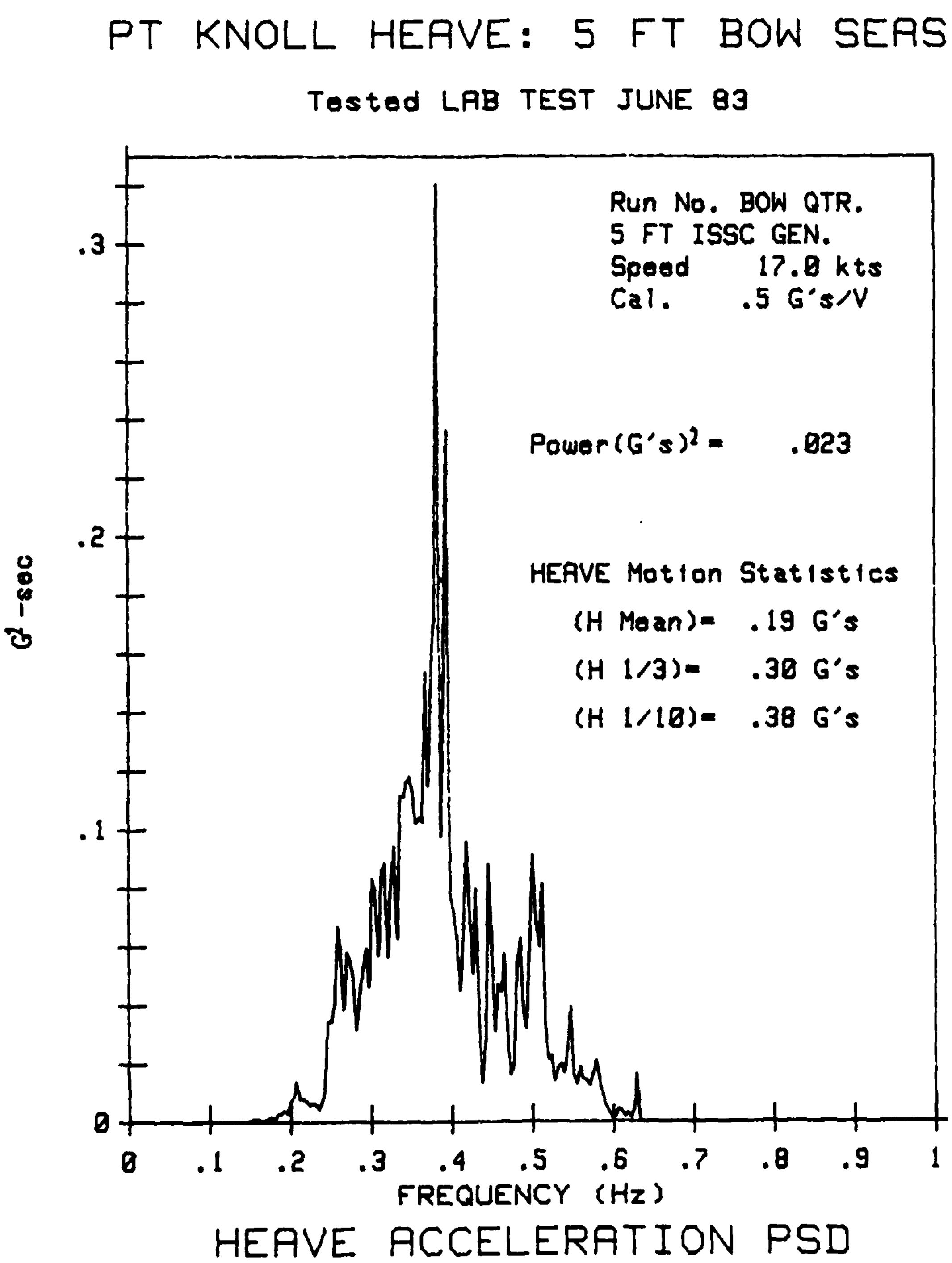

FIGURE C-57. PT KNOLL Heave PSD Plot, 5 Ft Bow Seas

TABLE C-LVII
PT KNOLL Heave PSD
5 Ft Bow Seas

PT KNOLL HEAVE: 5 FT BOW SEAS

HEAVE Energy Spectrum
Tested LAB TEST JUNE 83

Run No. BOW QTR., Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.039063	0.000000E+00
.078125	1.112030E-17
.117188	7.265126E-08
.156250	9.658826E-04
.195313	3.190709E-03
.234375	4.556816E-03
.257813	6.702316E-02
.265625	3.848380E-02
.269531	5.778121E-02
.273438	5.491329E-02
.281250	3.148452E-02
.292969	5.925395E-02
.296875	4.623918E-02
.300781	8.312285E-02
.308594	5.695380E-02
.312500	8.607943E-02
.316406	8.810320E-02
.320313	5.628505E-02
.328125	9.426003E-02
.332031	6.263610E-02
.347656	1.177273E-01
.351563	1.126099E-01
.355469	1.019097E-01
.359375	1.034993E-01
.363281	1.027283E-01
.367188	1.537296E-01
.371094	1.147827E-01
.382813	3.204493E-01
.386719	9.737487E-02
.390625	1.637475E-01
.394531	2.361143E-01
.410156	4.499877E-02
.417969	9.608710E-02
.425781	5.071287E-02
.429688	7.982282E-02
.437500	1.334017E-02
.445313	8.817370E-02
.453125	3.086648E-02
.457031	4.689417E-02
.460938	4.467627E-02
.464844	5.747970E-02
.468750	3.177242E-02
.472656	1.623458E-02
.484375	6.256298E-02
.492188	3.183927E-02
.500000	9.120054E-02
.507813	5.996364E-02
.511719	8.132447E-02
.519531	2.121226E-02
.546875	3.935985E-02

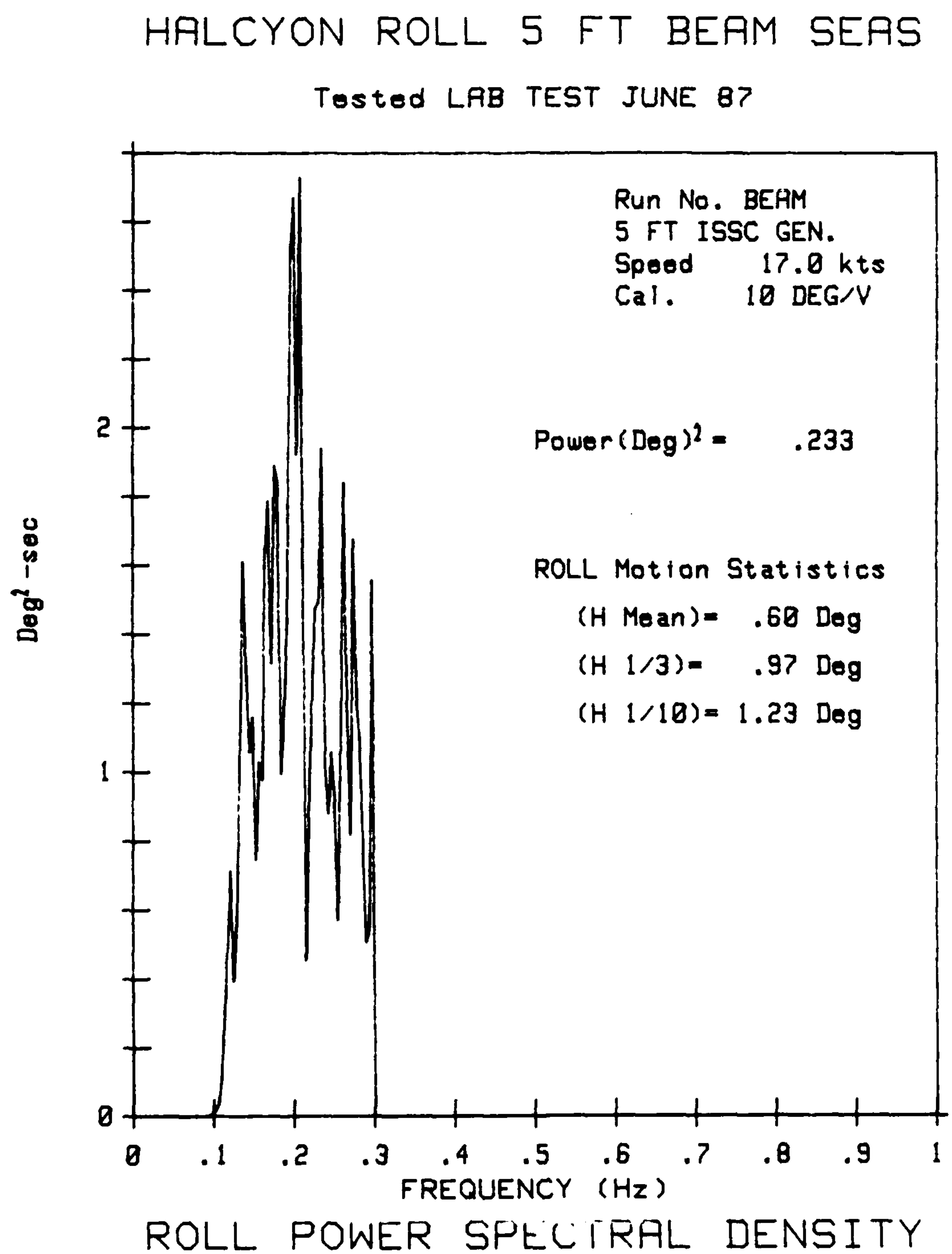

FIGURE C-58. HALCYON Roll PSD Plot, 5 Ft Beam Seas

TABLE C-LVIII
HALCYON Roll PSD
5 Ft Beam Seas

HALCYON ROLL 5 FT BEAM SEAS

ROLL Energy Spectrum
Tested LAB TEST JUNE 87

Run No. BEAM, Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.078125	1.238517E-06
.117188	4.970349E-01
.121094	7.102072E-01
.125000	3.925330E-01
.136719	1.609908E+00
.144531	1.055427E+00
.148438	1.157982E+00
.152344	7.442713E-01
.156250	1.026974E+00
.160156	9.772534E-01
.167969	1.784363E+00
.171875	1.314660E+00
.175781	1.886940E+00
.183594	9.920476E-01
.195313	2.523104E+00
.199219	2.668863E+00
.203125	1.919569E+00
.207031	2.725844E+00
.214844	4.522804E-01
.234375	1.937378E+00
.242188	8.780923E-01
.246094	1.055409E+00
.253906	5.696378E-01
.261719	1.838203E+00
.269531	8.185207E-01
.273438	1.674446E+00
.289063	5.046316E-01
.296875	1.556046E+00
.300781	0.000000E+00
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

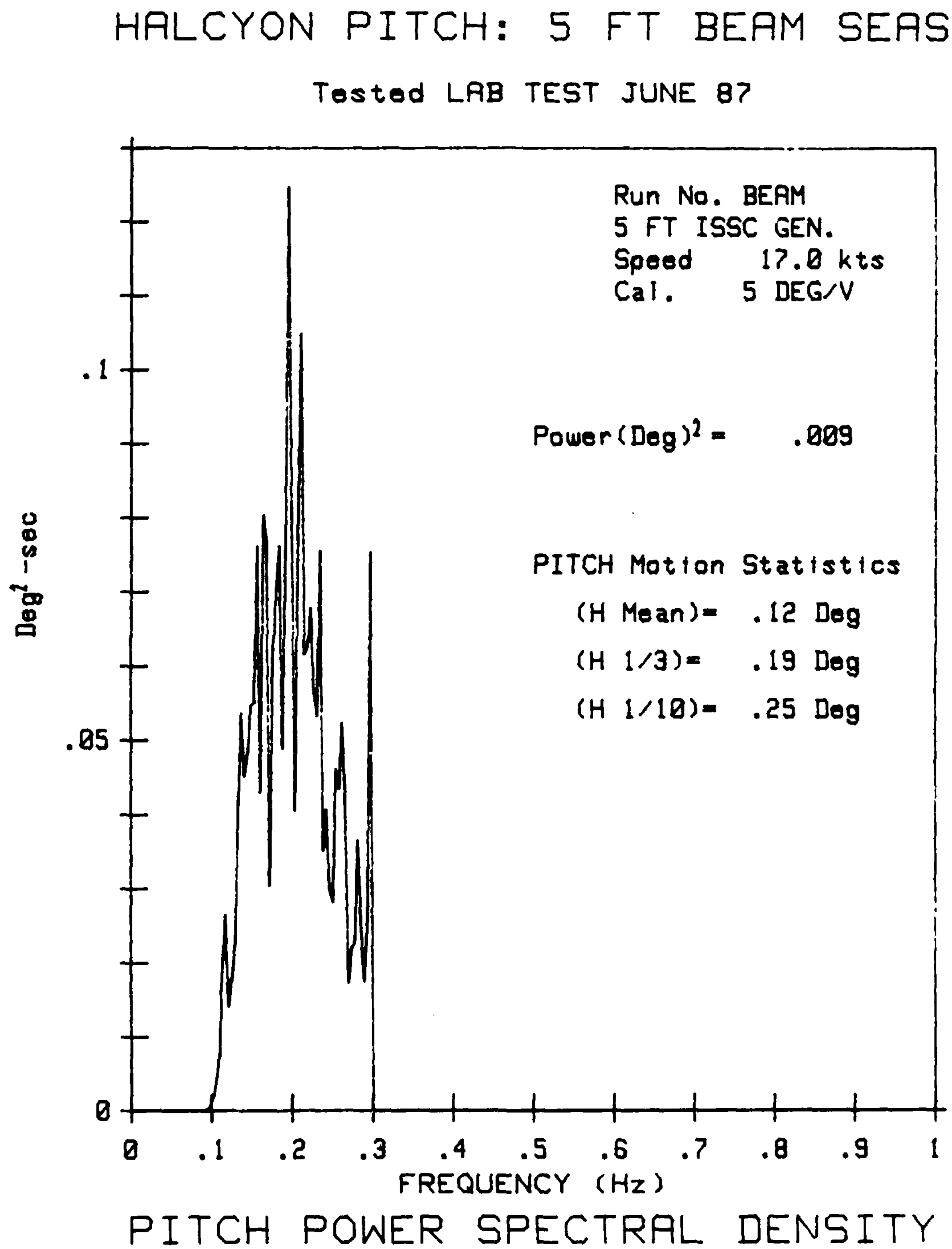

FIGURE C-59. HALCYON Pitch PSD Plot, 5 Ft Beam Seas

TABLE C-LIX
HALCYON Pitch PSD
5 Ft Beam Seas

HALCYON PITCH: 5 FT BEAM SEAS

PITCH Energy Spectrum
Tested LAB TEST JUNE 87

Run No. BEAM, Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.078125	1.336813E-07
.117188	2.648308E-02
.121094	1.408468E-02
.136719	5.363470E-02
.140625	4.518344E-02
.156250	7.612944E-02
.160156	4.287754E-02
.164063	8.025538E-02
.171875	3.024285E-02
.183594	7.611530E-02
.187500	4.878554E-02
.195313	1.246195E-01
.203125	4.044140E-02
.210938	1.047980E-01
.214844	6.150870E-02
.222656	6.780841E-02
.230469	5.321348E-02
.234375	7.546273E-02
.238281	3.507784E-02
.242188	4.066795E-02
.250000	2.808456E-02
.253906	4.610830E-02
.257813	4.347958E-02
.261719	5.231004E-02
.269531	1.719575E-02
.273438	2.159522E-02
.281250	3.652572E-02
.289063	1.745313E-02
.296875	7.528195E-02
.300781	0.000000E+00
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

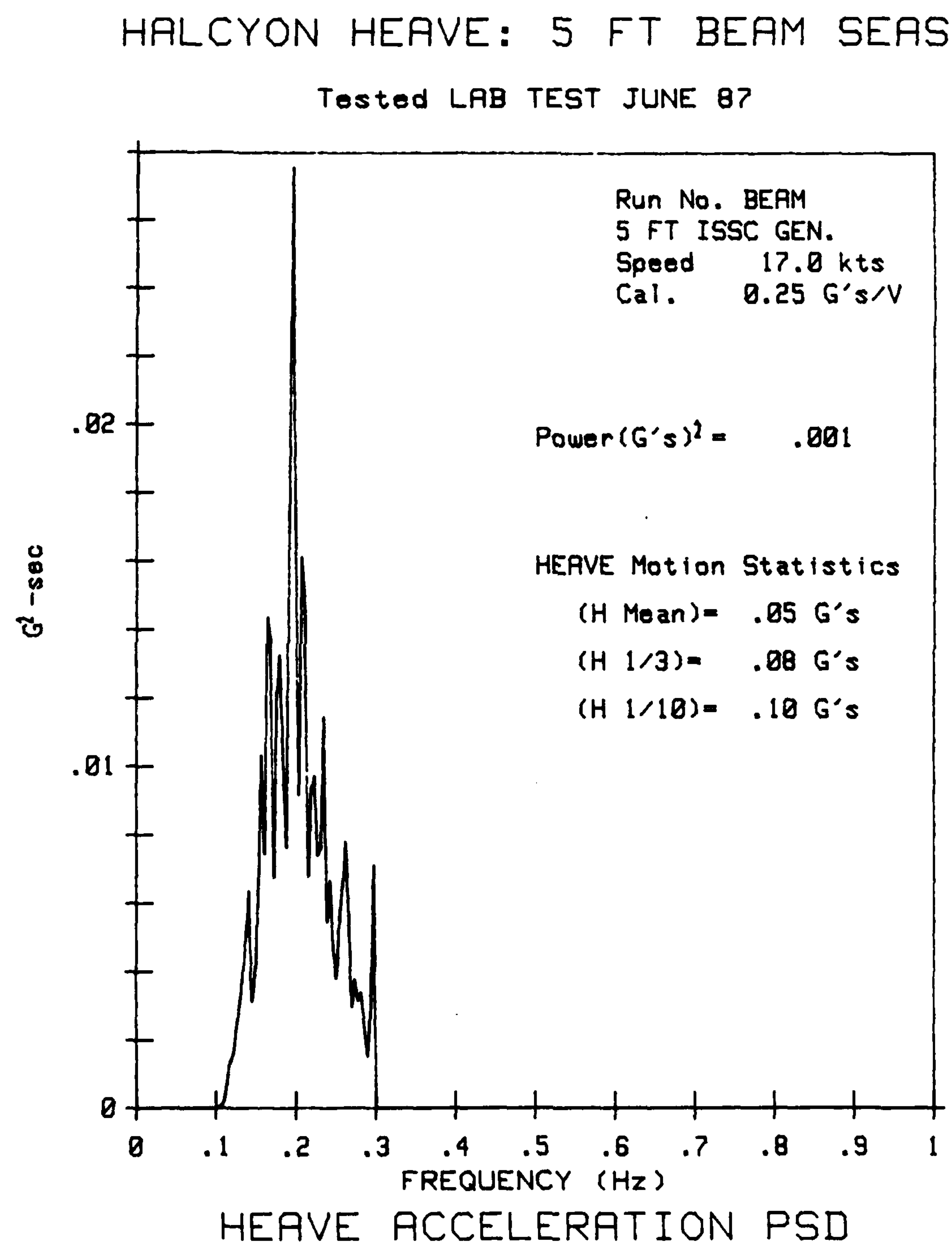

FIGURE C-60. HALCYON Heave PSD Plot, 5 Ft Beam Seas

TABLE C-LX
HALCYON Heave PSD
5 Ft Beam Seas

HALCYON HEAVE: 5 FT BEAM SEAS

HEAVE Energy Spectrum
Tested LAB TEST JUNE 87

Run No. BEAM, Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.039063	0.000000E+00
.078125	4.127428E-10
.117188	1.387382E-03
.140625	6.360824E-03
.144531	3.118445E-03
.156250	1.031368E-02
.160156	7.426339E-03
.164063	1.435476E-02
.171875	6.717997E-03
.179688	1.324967E-02
.187500	7.617530E-03
.195313	2.755113E-02
.203125	9.156384E-03
.207031	1.611888E-02
.214844	6.769557E-03
.222656	9.715019E-03
.226563	7.383484E-03
.234375	1.143873E-02
.238281	5.430560E-03
.242188	6.653903E-03
.250000	3.803476E-03
.261719	7.797095E-03
.269531	2.948314E-03
.273438	3.750710E-03
.277344	3.152349E-03
.281250	3.363872E-03
.289063	1.520097E-03
.296875	7.110935E-03
.300781	0.000000E+00
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

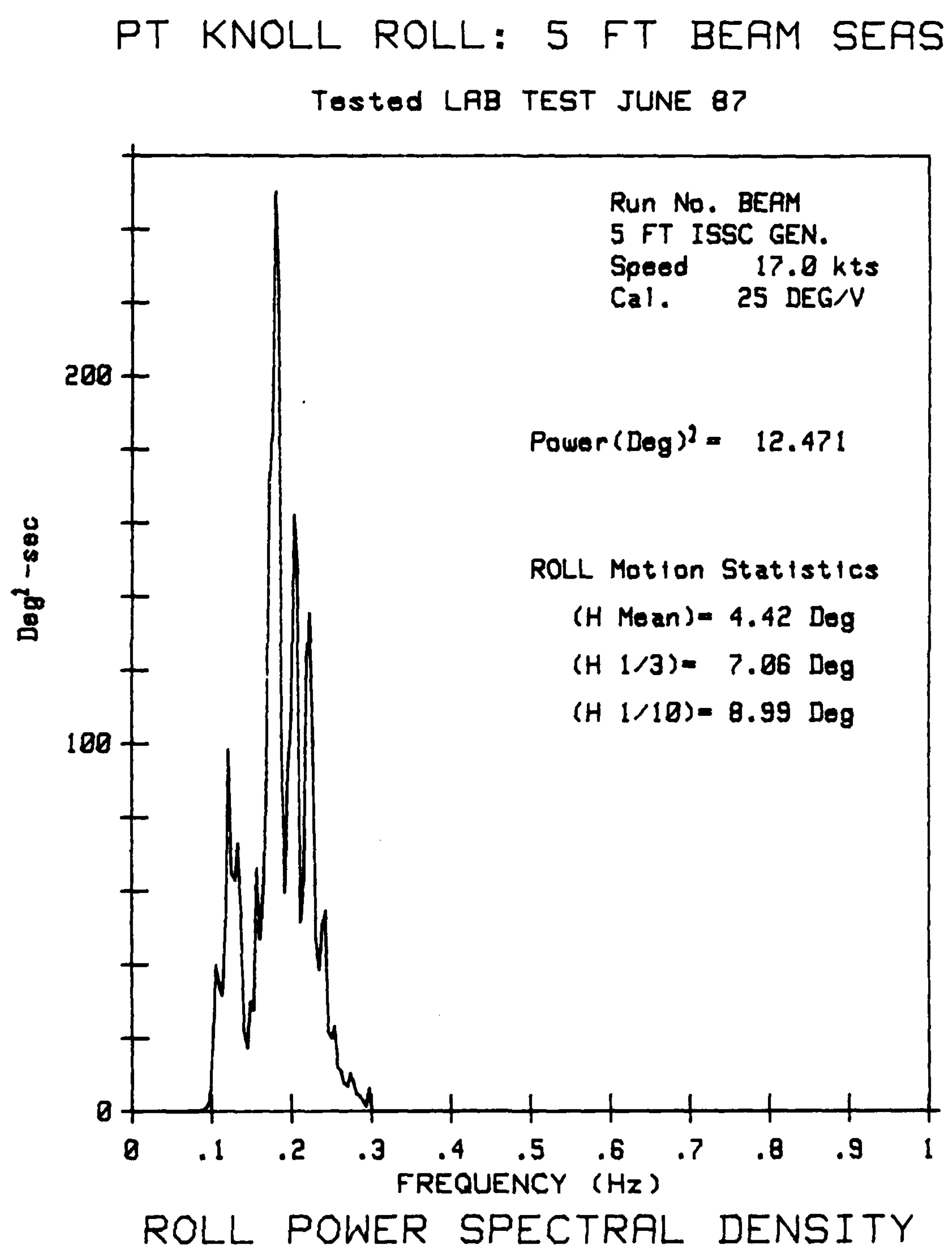

FIGURE C-61. PT KNOLL Roll PSD Plot, 5 Ft Beam Seas

TABLE C-LXI
PT KNOLL Roll PSD
5 Ft Beam Seas

PT KNOLL ROLL: 5 FT BEAM SEAS

ROLL Energy Spectrum
Tested LAB TEST JUNE 87

Run No. BEAM, Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.078125	7.508478E-04
.105469	3.981249E+01
.113281	3.141741E+01
.117188	5.016292E+01
.121094	9.848990E+01
.128906	6.285834E+01
.132813	7.289256E+01
.144531	1.719532E+01
.148438	2.984195E+01
.152344	2.764514E+01
.156250	6.609511E+01
.160156	4.678227E+01
.179688	2.501263E+02
.191406	5.939789E+01
.195313	9.377394E+01
.203125	1.619392E+02
.210938	5.126439E+01
.222656	1.354503E+02
.234375	3.847714E+01
.242188	5.460369E+01
.250000	1.993404E+01
.269531	6.919237E+00
.273438	1.032779E+01
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

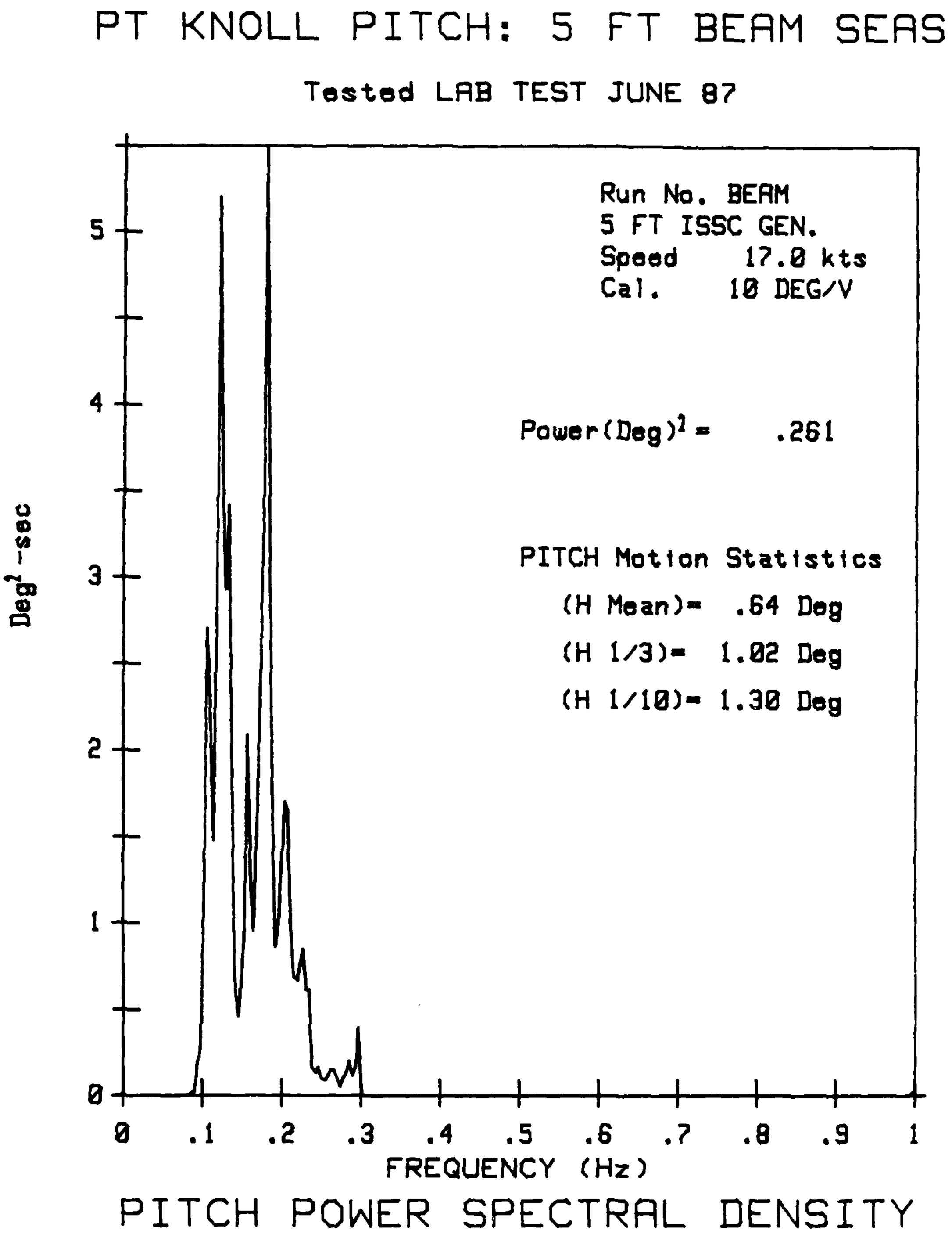

FIGURE C-62. PT KNOLL Pitch PSD Plot, 5 Ft Beam Seas

TABLE C-LXII
PT KNOLL Pitch PSD
5 Ft Beam Seas

PT KNOLL PITCH: 5 FT BEAM SEAS

PITCH Energy Spectrum
Tested LAB TEST JUNE 87

Run No. BEAM, Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (DEG SQR-SEC)
.039063	0.000000E+00
.078125	7.249375E-05
.105469	2.706468E+00
.113281	1.476763E+00
.117188	2.606142E+00
.121094	5.200324E+00
.128906	2.921290E+00
.132813	3.415942E+00
.144531	4.576909E-01
.156250	2.087946E+00
.164063	9.518121E-01
.179688	5.494170E+00
.191406	8.561787E-01
.195313	9.894866E-01
.203125	1.700146E+00
.218750	6.701199E-01
.226563	8.477575E-01
.234375	6.076919E-01
.242188	1.377648E-01
.273438	5.247453E-02
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00
.820313	0.000000E+00
.859375	0.000000E+00
.898438	0.000000E+00
.937500	0.000000E+00
.976563	0.000000E+00

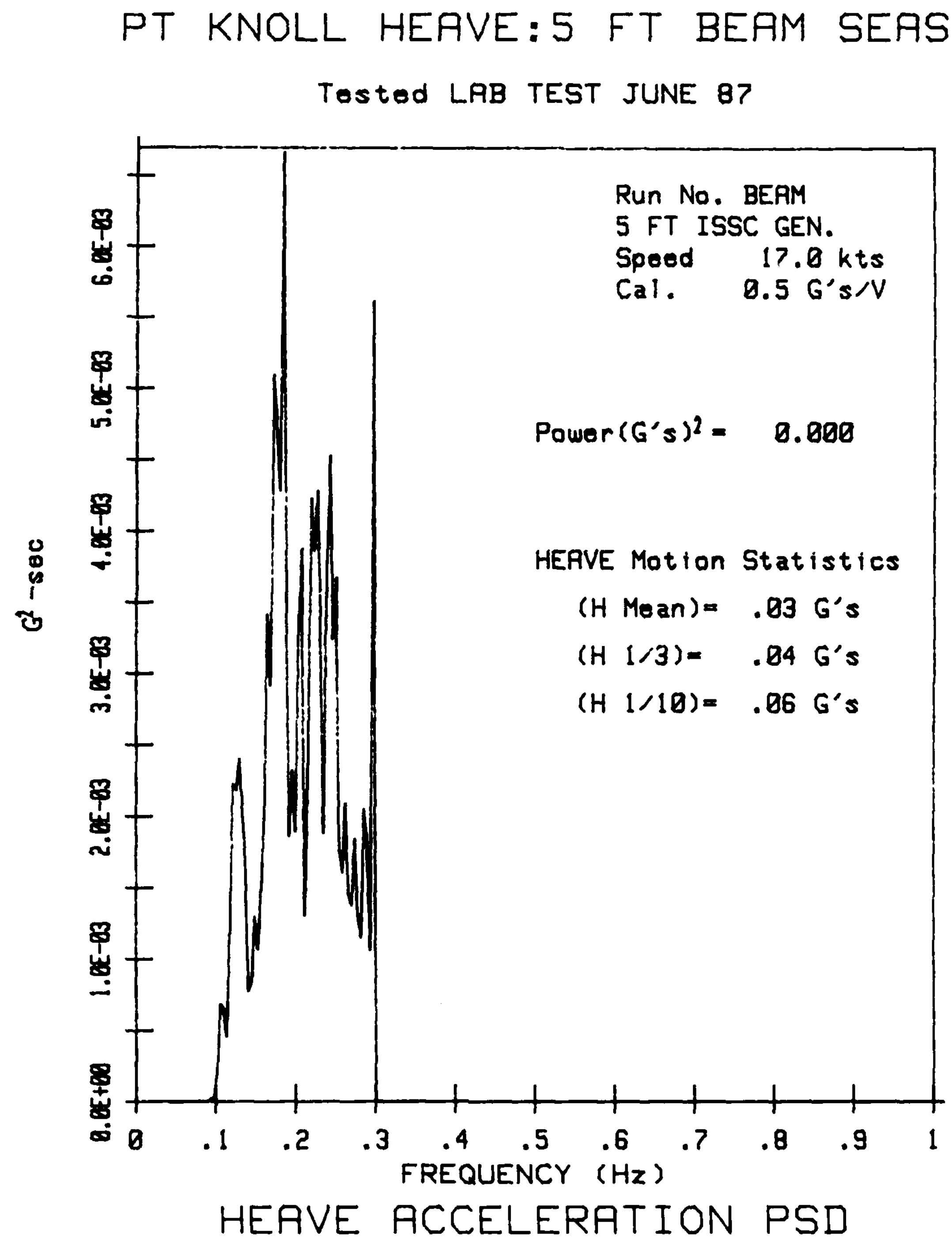

FIGURE C-63. PT KNOLL Heave PSD Plot, 5 Ft Beam Seas

TABLE C-LXIII
PT KNOLL Heave PSD
5 Ft Beam Seas

PT KNOLL HEAVE:5 FT BEAM SEAS

HEAVE Energy Spectrum
Tested LAB TEST JUNE 87

Run No. BEAM, Speed 17 , SEAS 5 FT ISSC GEN.

FREQUENCY OF ENCOUNTER (HERTZ)	AMPLITUDE (G SQR-SEC)
.039063	0.000000E+00
.078125	2.919040E-09
.105469	6.842713E-04
.117188	1.179076E-03
.121094	2.226879E-03
.125000	2.185070E-03
.128906	2.402981E-03
.140625	7.703698E-04
.148438	1.290875E-03
.152344	1.071625E-03
.156250	1.484742E-03
.164063	3.412394E-03
.167969	2.915571E-03
.171875	5.092103E-03
.179688	4.277870E-03
.183594	6.666167E-03
.191406	1.856124E-03
.195313	2.318072E-03
.199219	1.891033E-03
.207031	3.871770E-03
.210938	1.301774E-03
.218750	4.225916E-03
.222656	3.859030E-03
.226563	4.275931E-03
.234375	1.880731E-03
.242188	4.523553E-03
.246094	3.238226E-03
.250000	3.663517E-03
.257813	1.610707E-03
.261719	2.085307E-03
.269531	1.375247E-03
.273438	1.838361E-03
.281250	1.152443E-03
.285156	2.047695E-03
.292969	1.057114E-03
.296875	5.605685E-03
.300781	0.000000E+00
.312500	0.000000E+00
.351563	0.000000E+00
.390625	0.000000E+00
.429688	0.000000E+00
.468750	0.000000E+00
.507813	0.000000E+00
.546875	0.000000E+00
.585938	0.000000E+00
.625000	0.000000E+00
.664063	0.000000E+00
.703125	0.000000E+00
.742188	0.000000E+00
.781250	0.000000E+00

APPENDIX D

HALCYON STABILITY TEST DATA

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DEPARTMENT OF TRANSPORTATION
U. S. COAST GUARD
CG-000 (Rev. 1-67)

APPENDIX B to NVC

UNITED STATES COAST GUARD

STABILITY TEST DATA

OFFICIAL No. ....

Gross tons 28

Description of vessel 60' SWATH	Owner RMI
Type Semi Submerged Catamaran	Owner's address 225 W 30 St National City CA
Builder RMI	Vessel inclined at 24th St. National City
Hull No. 1 Date Built 1985	Date .... Time ....
Hull	Test requested by ....
Machinery Diesels	Plans furnished by RMI
Caterpillar 3408 DI-TA	Offsets measured by Deb Mitter, NA
	Curves of form computed by Deb Mitter, NA
Classed by .... Inspected ☐ Safety certificate ☐ Load line ☐	Test conducted by Alexander Warnck, NA
Route: Ocean ☒ Coastwise ☒ Great Lakes ☐ Bays ☐ Rivers ☐	Stability calculations made by Alexander Warnck, NA
Specify route, if limited	Duplicate vessels NONE

Previous Edition May Be Used

GPO 9a3-653

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U. S. COAST GUARD
CG-993-1 (Rev. 8-67)

STABILITY TEST

PRINCIPAL DIMENSIONS

Length over all	60 feet	0 inches	(feet).
Length between perpendiculars which are at the extremities of ______ water line	59 feet	0 inches	(feet).
Length between draft marks, ______ condition	59 feet	0 inches	(feet).
Breadth, extreme, at ______ feet ______ inches above base	30 feet	0 inches	(feet).
Breadth, molded, ☒ at ______ feet ______ inches above base	feet	inches	(feet).
Breadth at load water line	feet	inches	(feet).
Depth amidships, from baseline to freeboard deck	14 feet	0 inches	(feet).
Apparent full-load mean draft for stability — molded base	feet	inches	(feet).
Apparent full-load mean draft for stability — bottom of keel	feet	inches	(feet).
Displacement, sea water, long tons (2,240 lb.), at above full-load draft	tons.		
Freeboard amidships at above full-load draft	feet	inches	(feet).
Freeboard at low point of sheer (0 feet aft of ☒)	13 feet	9 inches	(feet).

Location of ports, in hull, which may affect stability: None

GENERAL INFORMATION

Names and duties of official observers	Lt.
Designers represented by	a B Warrick
Builders represented by	a B Warrick
Owners represented by	a B Warrick
Weather, tide, and mooring conditions	Calm, high, untethered
Condition of ship as to completeness and as to water in boilers, machinery, and bilges (see note at bottom of sheet 5)	Complete lightship, empty tanks

U. S. GOVERNMENT PRINTING OFFICE 16—

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PREVIOUS EDITION MAY BE USED

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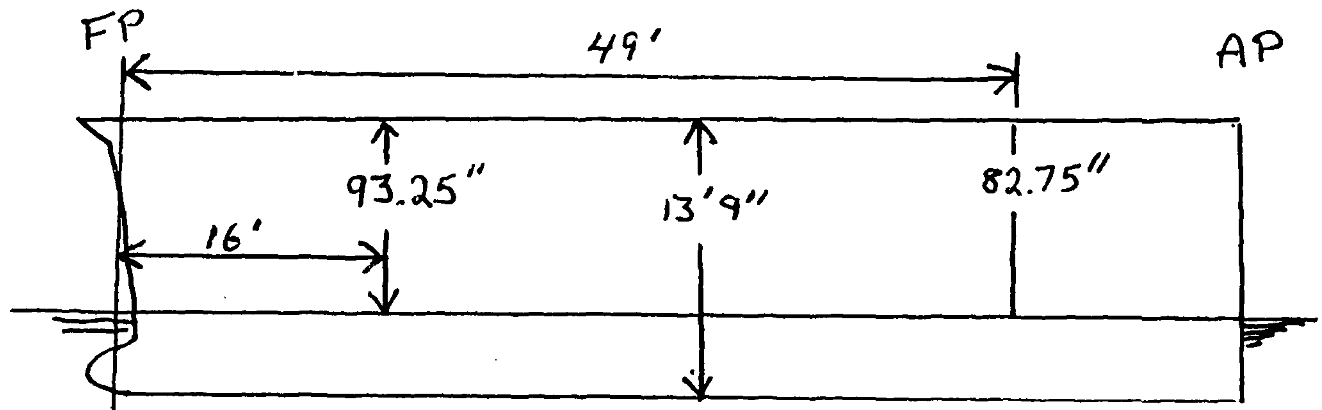
CG-993-2 (Rev. 8-67)

STABILITY TEST RMI Halcyon

All tons used in this calculation are of .... pounds

SHIP AT TIME OF STABILITY TEST—CONDITION O



SKETCH SHOWING HOG, SAG, TRIM, DRAG, AND LOCATION OF DRAFT MARKS, FREEBOARDS, AND PERPENDICULARS
(Except where accuracy of draft marks have been verified by U. S. C. G., freeboards must be furnished)

Draft when inclined (check) ☐ (From draft marks) ☒ (From freeboards)	Forward		5	feet	6½	inches
	Aft		7	feet	1½	inches
	Amidships (Must be recorded)	Port	6	feet	2½	inches
		Starboard	6	feet	5½	inches
Distance between "curves of form" perpendiculars			59'			feet
Bottom of keel below base line						inches
Molded / Keel drafts corrected to "curves of form" perpendiculars for use in calculations	Forward					feet
	Aft					feet
	Mean of amidships P and S					feet

Mean of forward and after drafts	6.33	feet
Hog or sag	0	feet
Trim ~~forward~~, aft	1.56	feet
Longitudinal center of flotation ~~forward~~, aft ⊠	2.47	feet
Molded / Keel draft at center of flotation	6.39	feet
Molded / Keel draft at L. C. F. corrected for hog or sag	6.39	feet
Total displacement at above draft ~~F. W.~~, S. W.	55.11	tons
Specific gravity of water 1.023 equals		cubic feet per ton
Total displacement corrected for density	54.9	tons

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GPO 901-126

STABILITY TEST

SHIP AT TIME OF STABILITY TEST—CONDITION ⊙

Pendulums

No.	Location	Length to Batten (Inches)
1st	8" aft of FP	77.0
2d	29' 8" aft of FP	134.25
3d	55' aft of FP	90.9

Inclining Weights

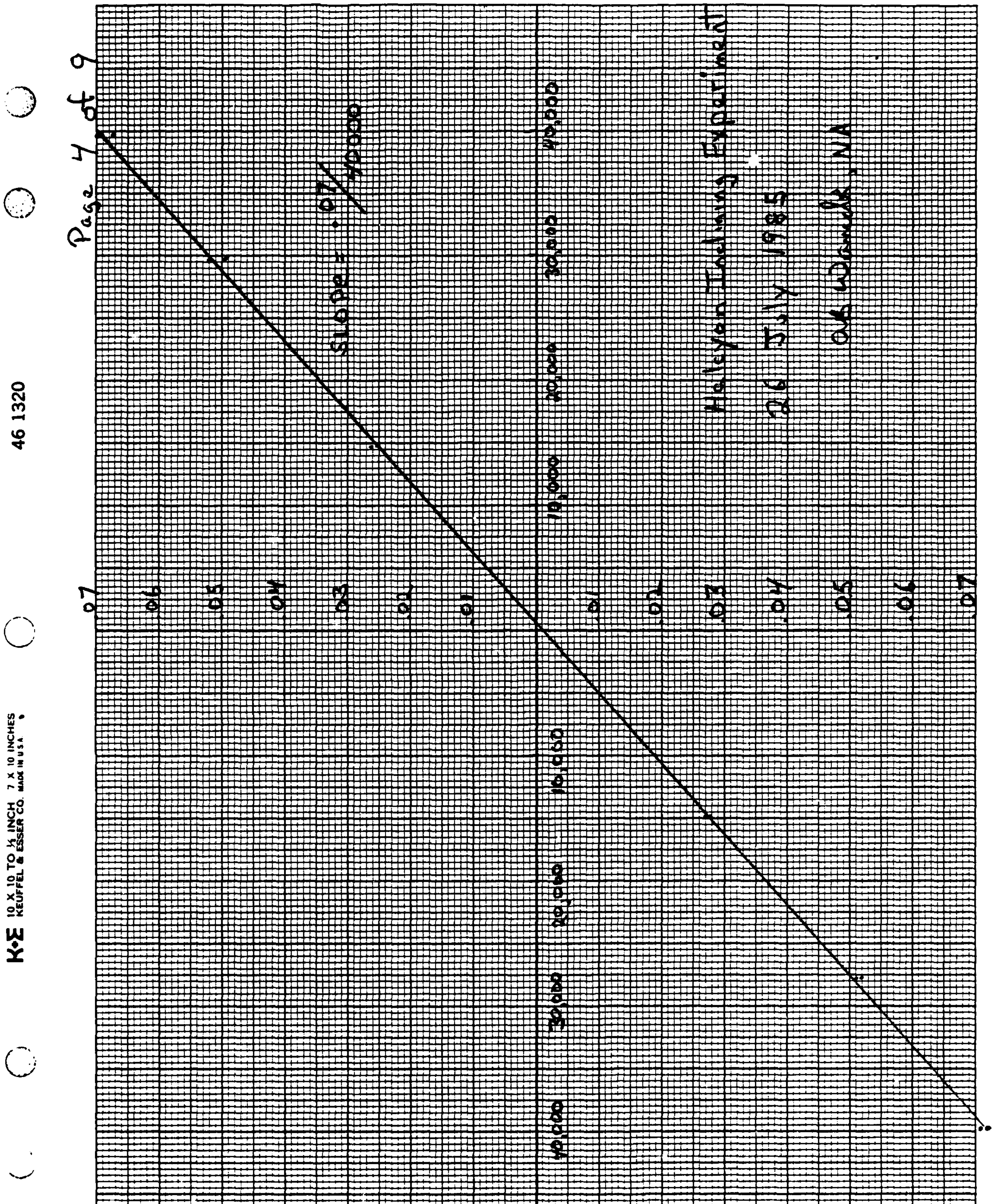
Location 31' aft of FP

Description Steel Block

No.	Weight (lbs)	Initial Position Port (Feet)	Initial Position Starboard (Feet)
1	2960	0	

Trial	No.	Weight (lbs)	Distance From Initial Position: Port (inches)	Distance From Initial Position: Starboard (inches)	Moment (ft-lbs)	Total Inclining Moment: Port (ft-lbs)	Total Inclining Moment: Starboard (ft-lbs)	Pendulum Deflections No.	Pendulum Deflections Port (Inches)	Pendulum Deflections Starboard (Inches)	Tangent Port	Tangent Starboard
1st trial	1	2960	60.25		14861	14861		1st	1.94		.0252	
								2d	3.50		.0261	
								3d	2.38		.0262	
2d trial	1	2960	120			29600		1st	3.81		.0495	
								2d	7.0		.0520	
								3d	4.78		.0526	
3d trial	1	2960	161.25			39775		1st	5.18		.0673	
								2d	9.30		.693	
								3d	6.38		.070	
4th trial	1	2960	162				39960	1st		5.44	.071	
								2d		9.75	.072	
								3d		6.56	.072	
5th trial	1	2960	11.5				28367	1st		4.00	.052	
								2d		6.94	.052	
								3d		4.62	.051	
6th trial	1	2960					14923	1st		2.12	.0275	
								2d		3.69	.0275	
								3d		2.44	.027	
7th trial								1st				
								2d				
								3d				
8th trial								1st				
								2d				
								3d				

GPO 83-31841



K+E 10 X 10 TO ½ INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.
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Page 4 of 9
SLOPE = .07/40000
Halcyon Icing Experiment
26 July 1985
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STABILITY TEST

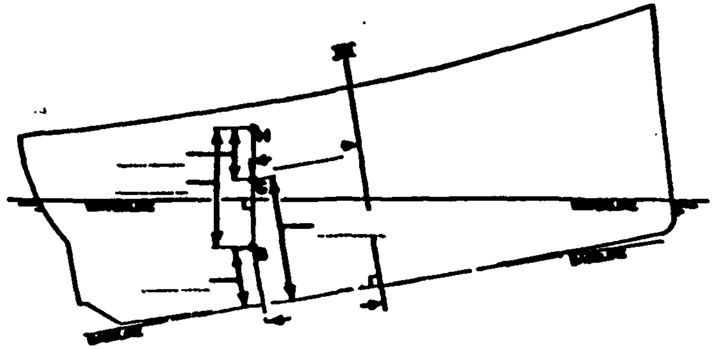
SHIP AT TIME OF STABILITY TEST—CONDITION ⊗

	FROM HYDROSTATIC CURVES		FROM INDEPENDENT CALCULATION	
Corrected displacement	549	tons.		tons.
Mean virtual metacentric height obtained from plot of inclining moments versus tangents of angles of heel — $\frac{\text{moment}}{\text{displacement} \times \text{tangent}}$	4.65	feet.		feet.
Correction for free surface	0	feet.*		feet.
Mean metacentric height G. M. =	4.65	feet.		feet.
Transverse metacenter above base line corresponding to draft at L. C. F. (corrected for hog or sag)	16.87	feet.†		
Transverse metacenter above base line corrected (for trim, and hog or sag)	16.87	feet.		
C. G. above base line	12.21	feet.		feet. (From figure)
Longitudinal metacenter above C. G. 22.16 - 12.21	9.95	feet.		
Moment to alter trim 1 foot, $\frac{\text{Longl. GM} \times \Delta}{L}$	9.26	ft.-tons.		
Trim by stern, bow	1.56	feet.†		
Trimming lever = $\frac{\text{Trim} \times \text{moment to trim}}{\text{displacement}}$	0.26	feet.		
L. C. B., forward, aft of ⊗, which is 29.5 feet forward, aft of frame No. 0	0.21	feet.		
C. G. forward, aft of ⊗	0.47	feet.		feet. (From figure)

Period of complete roll ________ seconds.

Apparent radius of gyration of vessel ________ $r = \frac{T\sqrt{GM}}{1.108}$ ________ feet.

Rolling constant ________ $C = \frac{T\sqrt{GM}}{B}$ ________



* Water in bilges. The bilges should be entirely free of water; but should this be impossible, correction should be made in the derived G. M. The details of this correction should form part of this report.

† If the trim is excessive, independent calculations should be made to obtain the positions of center of buoyancy and transverse metacenter and the position of the center of gravity determined therefrom. These calculations should be incorporated in this booklet. (See Page 3a)

PREVIOUS EDITION MAY BE USED

GPO 860-458

GPO 861-996

STABILITY TEST

ITEMS TO BE ADDED

DESCRIPTION	WEIGHT	VERTICAL CENTER	LONGITUDINAL CENTER
Below is summary of missing belt drive units - one side			
Lower Shaft	448 lbs.	2.7	38.5
Smooth Idler	347 lbs.	11.4	38.5
Take-up Unit	289 lbs	14.4	38.5
Upper Shafts	375 lbs	13.2	38.5
Belts	86 lbs	9.2	38.5
TOTAL - Both Sides	3090 lbs	9.36	38.5

TANKS

DESCRIPTION	LOCATION	SOUNDING OR ULLAGE	SPECIFIC GRAVITY / DENSITY
None -Ship tanks all empty			

STABILITY TEST

ITEMS TO BE REMOVED

DESCRIPTION	WEIGHT	VERTICAL CENTER - above baseline	LONGITUDINAL CENTER - from FP
Tripods, Oil, Troughs	225 lbs	14.5	33
Humans	550 lbs	15.75	33
Inclining Weight	2960 lbs	14.75	30
Total	3735	14.88	31.2

TANKS

DESCRIPTION	LOCATION	SOUNDING OR ULLAGE	SPECIFIC GRAVITY / DENSITY

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STABILITY TEST

SHIP LIGHT—CONDITION I

Ship complete in every respect, with water in boilers at steaming level and liquids in machinery and piping, but with all tanks and bunkers empty and no passengers, crew, cargo, stores, or baggage on board

LIST OF MAJOR EQUIPMENT, ETC., INCLUDED IN CONDITION I, AS SHOWN
Ballast, Boats, Rafts, Cargo Booms, Anchors, Guns, Armor, Etc.

Items	Weight Tons	C. G. Above Base Feet	C. G. From M. P. Feet For'd	C. G. From M. P. Feet Aft
Fixed ballast (Furnish plan)				

Items	Displacement and Weight Tons	C. G. Above Base Lever	C. G. Above Base Vertical Moments Ft-lbs	C. G. From M. P. Feet Aft	C. G. From M. P. After Moments Ft-tons	C. G. From M. P. Feet For'd	C. G. From M. P. Forward Moments Ft-tons
Ship in Condition 0	54.9	12.21	1501537	0.47	57798		
Weight to complete	3090 lbs	9.36	28922	9.5	29355		
Foreign weight—to be deducted	3735 lbs	14.88	55577	0.7	2614		
Ship in Condition I	54.6	12.06	1474882	0.69	84539		

Molded keel } draft at longitudinal center of flotation corresponding to above displacement for salt water 6.29 feet.
Transverse metacenter above base at L. C. F. draft, uncorrected for trim 16.75 feet.
Transverse metacenter above base, corrected for trim 16.75 feet.
C. G. above base 12.06 feet.
Metacentric height, uncorrected for trim, G. M 4.695 feet.
Metacentric height, corrected for trim, G. M 4.695 feet.

Longitudinal metacenter above C. G. at L. C. F. draft 9.99 feet.
Moment to alter trim 1 foot at L. C. F. draft, $\frac{\text{Long'l. GM} \times \Delta}{L}$ 9.24 foot-tons.
C. B. of ship on even keel at L. C. F. draft, aft, forward of M 0.16 feet.
C. G. aft, ~~forward~~ of M 0.69 feet.
Trimming lever 0.53 feet.
Trim, aft, forward $\frac{\text{Displacement} \times \text{lever}}{\text{Moment to trim}}$ 3.14 feet.

Longitudinal center of flotation, aft, forward of M 1.83 feet.
Difference between L. C. F. and M draft 0.10 feet.
Molded draft amidships 6.19 feet.
Draft on draft marks, forward 4 feet 7 inches.
Draft on draft marks, aft 7 feet 9 inches.

GPO 961-129

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STABILITY TEST

Data for Tanks				Items (Include list of tanks completely empty)	Weight	C. G. Above Base		C. G. From M. P.			
Liquid	Sound'g	Net Inertia of Free Surface	Inertia Feet³/Ton		Tons	Lever	Vertical Moments Ft-tons	Feet Aft	After Moments Ft-tons	Feet Fwd	Forward Moments Ft-tons
	0	0	0	SW Tank 1 & 2	0	2.23	0			25.28	0
	0	0	0	SW Tank 3 & 4	0	2.21	0			16.6	0
	0	0	0	FO Tank 1 & 2	0	2.13	0			1.5	0
	0	0	0	FO Tank 2 & 3	0	2.13	0	3.0			0
	0	0	0	FW Tank	0	12.75	0			6.0	0
	0	0	0	Holding tank	0	13.08	0			15.15	0
	0	0	0	SW Tank 5 & 6	0	6.77	0	22.2			0

NOTE: Furnish tank sounding tables and plan of sounding tube locations unless previously submitted.)

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